Low Impact Development Cost Comparison

PREPARED FOR:

WSU Cooperative Extension
Pierce County
3049 South 36th Street, Suite 300
Tacoma, WA 98409

PROJECT:

Low Impact Cost Comparison
Pierce County, Washington

203386.30

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1.0 INTRODUCTION

AHBL Inc. was retained by WSU Cooperative Extension, Pierce County, to evaluate the relative construction costs between conventional development systems and Low Impact Development (LID) best management practices (BMP's). The project includes reviewing eight major development practices with several site variation scenarios. Each scenario is individually reviewed to develop an opinion of probable construction costs. It is important to note that these are simplified scenarios that may not include all the details that may be present on a particular site. These details include variations such as topographic relief, soil conditions, groundwater conditions, and climatalogical conditions.

All hydrologic modeling has been performed utilizing the Western Washington Hydrology Model as developed by the Washington State Department of Ecology (DOE). Existing conditions for detention size determination are all modeled as forests in good condition as required by the 2003 Department of Ecology *Stormwater Management Manual for Western Washington* (Stormwater Manual). Analysis of lot-scaled BMP's are based on a 5000 square foot lot with 2,000 square feet of roof coverage, 500 square feet of driveway and 2,500 square feet of turf/landscaping.

Cost provided are based on initial construction and do not include life cycle analysis or annual maintenance costs.

2.0 BIORETENTION CELL VS. INFILTRATION TRENCHES

This analysis consists of comparing the relative construction costs of underground infiltration trenches versus bioretention cells for managing stormwater runoff from equivalent tributary areas. For this analysis, several scenarios have been considered including different tributary area characteristics (i.e. roof runoff, driveway runoff) and different soil types (outwash soils, till soils). For BMP's it is assumed that a minimum of three feet of separation from the bottom of the facility to the seasonal high groundwater elevation or hardpan can be maintained.

For infiltration trenches, it is assumed that the void ration of the washed rock is approximately 30 percent. Infiltration through the sidewalls of the trench is neglected. The maximum ponding depth in bioretention swales is 6 inches. The systems have been designed to infiltrate 100 percent of the anticipated runoff for all storm events as predicted by WWHM. It should be noted that bioretention cells are typically not designed for 100 percent infiltration of the larger storm events. However, this method was chosen to enable a direct comparison with infiltration trenches which are, in most cases, designed to infiltrate all storm events. The comparisons will be similar for analysis completed to infiltrate a lesser percentage of all predicted stormwater runoff volumes.

2.1 Roof Runoff, Outwash Soils

The is scenario compares the cost of infiltration trenches versus bioretention cells for management of roof runoff from a standard residential roof (2000 square feet) for a site with outwash soils. The stormwater runoff in this case does not require treatment prior to infiltration.

	Item	Unit Cost	Quantity	Cost
Infiltration Trench				
	Washed Rock	$20/CY	5 CY	$100.00
	4" Perf. Pipe	$8/LF	15 LF	$120.00
	Catch Basin	$700/EA	1 EA	$700.00
	Excavation	$4.50/CY	5 CY	$22.50
			Total	**$942.50**
Bioretention Cell				
	Soil Mix	$25/CY	25 CY	$625.00
	Planting	$1/SF	450 SF	$450.00
	Mulch	$20/CY	4 CY	$80.00
	Excavation	$4.50/CY	25 CY	$112.50
			Total	**$1,267.50**
			Difference	**$325.00**

2.2 Roof Runoff, Till Soils

This scenario matches the previous scenario with the exception of soil type. This scenario uses till soils in the modeling which has a lower infiltration rate than outwash soils. Note that the size of the bioretention swale has not changed from the outwash to the till condition. This study assumes that the infiltration rate of bioretention soil mix is similar to underlying till soils and therefore restricts the infiltration rate in the outwash soils. An assumed infiltration rate for the bioretention soil mix of 1 inch per hour was utilized for stormwater modeling. Infiltration rates ranging from 1 to 2.4 inches per hour are commonly used for bioretention cells.

	Item	Unit Cost	Quantity	Cost
Infiltration Trench				
	Washed Rock	$20/CY	33 CY	$660.00
	4" Perf. Pipe	$8/LF	100 LF	$800.00
	Catch Basin	$700/EA	2 EA	$1400.00
	Filter Fabric	$0.50/SF	900 SF	$450.00
	Excavation	$4.50/CY	33 CY	$148.50
			Total	**$3,458.50**
Bioretention Cell				
	Soil Mix	$25/CY	25 CY	$625.00
	Planting	$1/SF	450 SF	$450.00
	Mulch	$20/CY	4 CY	$80.00

	Excavation	$4.50/CY	25 CY	$112.50
			Total	**$1,267.50**
			Difference	**$2,191.00**

2.3 Driveway Runoff, Outwash Soils

The third scenario analyzes infiltration facility requirement for driveway runoff. For this scenario the standard driveway area is considered to be 500 square feet. Infiltration trenches are typically not recommended for infiltration of runoff from pollution generating impervious surfaces in outwash soils because of the limited treatment capacity of the underlying soils. Therefore, a separate treatment facility would be necessary prior to infiltration. There is an extensive range of treatment options that could be utilized depending on individual site conditions and the costs of these treatment options are highly variable. For the purposed of this analysis, it has been assumed that the project will utilize a catch basin type treatment unit similar to the catch basin filter manufactured by Stormwater Management Inc. Stormwater treatment in a bioretention cell is provided by plant uptake and the filtering of the stormwater through the bioretention soil mix.

	Item	Unit Cost	Quantity	Cost
Infiltration Trench				
	Washed Rock	$20/CY	1.5 CY	$30.00
	4" Perf. Pipe	$8/LF	5 LF	$40.00
	Treatment Catch Basin	$2,000/EA	1 EA	$2,000.00
	Filter Fabric	$0.50/SF	45 SF	$22.50
	Excavation	$4.50/CY	1.5 CY	$6.75
			Total	**$2,099.25**
Bioretention Cell				
	Soil Mix	$25/CY	4 CY	$100.00
	Planting	$1/SF	68 SF	$68.00
	Mulch	$20/CY	.75 CY	$15.00
	Excavation	$4.50/CY	4 CY	$18.00
			Total	**$201.00**
			Difference	**$1,898.25**

2.4 Driveway Runoff, Till Soils

This scenario is the same as the previous except the native soils are modeled as till soils. In this case, treatment is not required for runoff prior to infiltration in the infiltration trench because till soils have a greater pollutant removal capacity. For proper treatment to be achieved, three feet of separation must be maintained from the bottom of the trench to the seasonal high ground water elevation.

	Item	Unit Cost	Quantity	Cost
Infiltration Trench				
	Washed Rock	$20/CY	8 CY	$160.00
	4" Perf. Pipe	$8/LF	25 LF	$200.00
	Catch Basin	$700/EA	1 EA	$700.00
	Filter Fabric	$0.50/SF	225 SF	$112.50
	Excavation	$4.50/CY	8 CY	$36.00
			Total	**$1,208.50**
Bioretention Cell				
	Soil Mix	$25/CY	6 CY	$90.00
	Planting	$1/SF	112 SF	$112.00
	Mulch	$20/CY	1 CY	$20.00
	Excavation	$4.50/CY	6 CY	$27.00
			Total	**$309.00**
			Difference	**$899.50**

As described above, the size of the bioretention cell does not vary from till soils to outwash soils based on the infiltration rate assumptions made for this study.

3.0 STANDARD ROAD VS. LID ROAD SECTION

This section reviews the construction costs differences between a standard 24-foot asphalt pavement road section with curb and gutter and closed conveyance and a LID road section with 24 feet of pavement but bioretention swales replace the curb and gutter and closed conveyance system. The analysis has been performed on a typical 1000 foot length of road. This analysis does not include site specific cost parameters such as clearing requirements, rough grading, erosion control BMP's, etc.

3.1 Standard Road Section

The standard road section consists of 24-feet of crowned asphalt concrete pavement with curb and gutter on each side. Average catch basin spacing is assumed to be 250 feet and all storm conveyance pipes are 12-inches in diameter. A 5-foot concrete sidewalk is provided on each side of the road. The assumed asphalt section is 2 inches of Class B asphalt over 2 inches of crushed surfacing top course (CSTC) and 6 inches of gravel base. The detention volume required for 1000 feet of road is 27,617 cubic feet and the treatment volume is 6011 cubic feet. For cost comparisons, it is assumed that stormwater management is provided by a combination wetpond with live detention storage. Detention and treatment volumes include runoff from adjacent driveways. The project assumes forty driveways along the 1000-foot length of road with a standard area of 500 square feet each.

3.2 LID Road Section

The LID road section consists of 24-feet of crowned asphalt concrete pavement with bioretention swales on each side in place of curb and gutter. A 4-foot grass shoulder is provided between the edge of the paved surface and the bioretention swale. The swale is intercepted by 20 foot wide residential driveways every 50 feet on center. A 12-inch culvert, 25 feet long, is provided under each driveway. A 5-foot concrete sidewalk is provided on each side of the road behind the proposed swales. The assumed asphalt section is the same as the standard road section. The stormwater modeling shows that the bioretention swale adequately infiltrates over 96-percent of the total stormwater runoff from the road and driveway surfaces. However, the swales are unable to meet the runoff rate and duration standards for large storm events. Therefore, a detention facility will be required after the swales. Because the swales infiltrate 96-percent of the runoff, exceeding the 91-percent storm treatment volume required by the Storm Manual, additional runoff treatment is not required.

3.3 Cost Summary

	Item	Unit Cost	Quantity	Cost
Standard Road Section				
	Class B Asphalt (2")	$35/CY	148 CY	$5,180.00
	CSTC (2")	$15/CY	148 CY	$2,220.00
	Gravel Base (6")	$12/CY	444 CY	$5,328.00
	Curb & Gutter	$15/LF	2,000 SF	$30,000.00
	Sidewalk	$30/SY	1,111 SY	$33,330.00
	Storm CB	$700/EA	8 EA	$5,600.00
	12" CPEP Storm	$18/LF	950 LF	$17,100.00
	Treatment Volume	$4.50/CY	223 CY	1,003.50
	Detention Volume	$4.50/CY	1,025 CY	4,612.50
			Total	**$104,374.00**
LID Road Section				
	Soil Mix	$25/CY	160 CY	$4000.00
	Swale Planting	$1/SF	2,880 SF	$2,880.00
	Mulch	$20/CY	30 CY	$60.00
	Swale Excavation	$4.50/CY	760 CY	$3,420.00
	Class B Asphalt (2")	$35/CY	148 CY	$5,180.00
	CSTC (2")	$15/CY	148 CY	$2,220.00
	Gravel Base (6")	$12/CY	444 CY	$5,328.00
	Sidewalk	$30/SY	1,111 SY	$33,330.00
	12" Culverts	$18/LF	720 LF	$12,960.00
	4" Perf. Pipe	$8/LF	2000 LF	$16,000.00
	Washed Rock	$20/CY	75 CY	$1,500.00
	Detention Volume	$4.50/CY	363	$1,633.50
			Total	**$88,311.50**
			Difference	**$16,062.50**

			Per LF	**$16.06/LF**

4.0 STANDARD VS. PERVIOUS ASPHALT PAVEMENT

This section compares the construction costs of Class B hot-mix asphalt pavement versus Pervious (open-graded) asphalt concrete pavement construction. The scope of this scenario is to perform research of published costs and project results and compare the cost of a typical pavement section for each pavement type. Detention and treatment volumes have been calculated and costs developed assuming a combined detention/wetpond is used for stormwater management. For this study, the pervious surfaces have been assumed to be hydrologically equivalent to grass.

The cost of pervious asphalt pavement varies considerably from source to source. Several sources stated that the cost of material and labor for the pervious asphalt is the same as standard asphalt. The difference is overall pavement cost is due to the difference in the pavement base. This cost analysis is based on that assumption. All costs are on a square foot of pavement basis.

	Item	Unit Cost	Quantity	Cost
Standard Pavement				
	Class B Asphalt (2")	$35/CY	0.006 CY	$0.21
	CSTC (2")	$15/CY	0.006 CY	$0.09
	Gravel Base (6")	$12/CY	0.019 CY	$0.23
	Treatment Volume	$4.50/CY	0.004 CY	$0.02
	Detention Volume	$4.50/CY	0.020 CY	$0.09
			Total	**$0.64**
Pervious Pavement				
	Pervious Asphalt (2")	$35/CY	0.006 CY	$0.21
	AASHTO No. 57 (2")	$15/CY	0.006 CY	$0.09
	AASHTO No. 3 (12")	$18/CY	0.037 CY	$0.66
	Treatment Volume	$4.50/CY	0.002 CY	$0.01
	Detention Volume	$4.50/CY	0.007 CY	$0.03
			Total	**$1.00**
			Difference	**$0.36**

5.0 RESIDENTIAL DRIVEWAY CONSTRUCTION

This section compares the costs of four construction materials for residential driveways. The five construction types are – standard asphalt pavement, pervious pavement, standard cement concrete, pervious cement concrete, eco-stone unit pavers. The standard residential driveway is assumed to be 500 square feet. Stormwater treatment and detention volumes have also been included in this cost analysis. This study assumes that pervious pavement systems are hydrologically similar to grass.

	Item	Unit Cost	Quantity	Cost
Standard Asphalt				
	Class B Asphalt (2”)	$50/CY	3 CY	$150.00
	CSTC (4”)	$25/CY	6 CY	$150.00
	Treatment Volume	$4.50/CY	2 CY	$9.00
	Detention Volume	$4.50/CY	10 CY	$45.00
			Total	**$354.00**
Pervious Asphalt				
	Pervious Asphalt (2”)	$50/CY	3 CY	$150.00
	AASHTO No. 57 (2”)	$25/CY	3 CY	$75.00
	AASHTO No. 3 (12”)	$25/CY	9 CY	$225.00
	Treatment Volume	$4.50/CY	1 CY	$4.50
	Detention Volume	$4.50/CY	3.5 CY	$15.75
			Total	**$470.25**
Standard Concrete				
	Cement Concrete (4”)	$155/CY	6 CY	$930.00
	CSTC (2”)	$25/CY	3 CY	$75.00
	Treatment Volume	$4.50/CY	2 CY	$9.00
	Detention Volume	$4.50/CY	10 CY	$45.00
			Total	**$1,059.00**
Pervious Concrete				
	Pervious Concrete (4”)	$205/CY	6 CY	$1,230.00
	AASHTO No. 57 (2”)	$25/CY	3 CY	$75.00
	AASHTO No. 3 (12”)	$25/CY	9 CY	$225.00
	Treatment Volume	$4.50/CY	1 CY	$4.50
	Detention Volume	$4.50/CY	3.5 CY	$15.75
			Total	**$1,550.25**
Pervious Pavers				
	Pervious Concrete (4”)	$4.50/SF	500 SF	$2,250.00
	AASHTO No. 8 (1”)	$25/CY	1.5 CY	$38.00
	AASHTO No. 57 (6”)	$25/CY	9 CY	$225.00
	Treatment Volume	$4.50/CY	1 CY	$4.50
	Detention Volume	$4.50/CY	3.5 CY	$15.75
			Total	**$2,533.25**

6.0 PARKING LOT DESIGN

This analysis evaluates the construction costs for a 20,000 square foot parking lot. The analysis compares the cost of a standard asphalt parking lot with an open pond for detention/treatment, a stormwater vault for detention/treatment, and a parking lot with pervious pavement with rock gallery storage under the pavement. Two scenarios were

evaluated for the pervious options. The first assumed an infiltration rate through the native subgrade of 0.5 inches per hour while the second assumes that there is no infiltration and the system functions as a detention system. The no infiltration case would be for sites where high groundwater elevations or other site constraints preventing any infiltration through the pavement subgrade.

	Item	Unit Cost	Quantity	Cost
Impervious Parking (Open Pond)	Class B Asphalt (2”)	$35/CY	123 CY	$4,305.00
	CSTC (4”)	$15/CY	246 CY	$3,690.00
	Detention Volume	$4.50/CY	445 CY	$2,002.50
	Treatment Volume	$4.50/CY	31 CY	$139.50
	Control Structure	$3,500/EA	1 EA	$3,500.00
	Catch Basin	$700/EA	2 EA	$1,400.00
	12” CPEP Storm	$18/LF	100 LF	$1,800.00
	Chain Link Fence	$7/LF	350 LF	$2,450.00
			Total	**$19,287.00**
Impervious Parking (Vault)	Class B Asphalt (2”)	$35/CY	123 CY	$4,305.00
	CSTC (4”)	$15/CY	246 CY	$3,690.00
	Detention Volume	$3.50/CF	10,672 CF	$37,352.00
	Treatment Volume	$3.50/CF	828 CF	$2,898.00
	Control Structure	3,500/EA	1 EA	$3,500.00
	Catch Basin	$700/EA	2 EA	$1,400.00
	12” CPEP Storm	$18/LF	100 LF	$1,800.00
			Total	**$54,945.00**
Pervious Parking (Infiltration)				
	Pervious Asphalt (2”)	$35/CY	123 CY	$4,305.00
	½ Gravel (2”)	$15/CY	123 CY	$1,845.00
	2”-4” Ballast (12”)	$18/CY	740 CY	$13,320.00
			Total	**$19,470.00**
Pervious Parking (No Infiltration)				
	Pervious Asphalt (2”)	$35/CY	123 CY	$4,305.00
	½ Gravel (2”)	$15/CY	123 CY	$1,845.00
	2”-4” Ballast (18”)	$18/CY	1,111 CY	$19,998.00
	Liner	$1/SF	21,200 SF	$21,200.00
	Control Structure	3,500/EA	1 EA	$3,500.00
	12” Perf. Pipe	20/LF	400 LF	$8,000.00
			Total	**$58,848.00**

7.0 SOIL REHABILITATION

Soil rehabilitation consists of adding compost material to site soils prior to applying sod or landscaping to provide a better growth medium and provide increased stormwater retention properties. This analysis reviews the cost of this practice from a stormwater management standpoint, but there are additional benefits including reduced chemical fertilizer requirements and watering needs and increased soil biota. The soil rehabilitation costs are based on the recommended practices as outlined in Guidelines & Resources for Implementing Soil Depth & Quality, BMP T.5.13, in WDOE Western Washington Stormwater Manual, 2002 funded by Snohomish County Public Works Department. Construction cost information has been obtained from several sources including *Guidelines for Landscaping with Compost-Amended Soils* for City of Redmond Public Works prepared by Chollak Services. The Tilled Compost-Amended Turf (TCT) consists of breaking up or tilling the top 6 to 8 inches of native soil material and adding a calculated quantity of mature compost. The compost is tilled into the native material with a goal of reaching an organic content of between 8 and 13-percent for the amended soil. As stated in the referenced report, costs can vary depending on native soil conditions, availability of compost material, and size and type of equipment that can be used on a particular site.

	Item	Unit Cost	Quantity	Cost
Minimum Input Turf (MIT)				
	Surface Preparation	$1.00/SF	2500 SF	$2,500.00
	Detention Volume	$4.50/CY	6.29 CY	$28.31
			Total	**$2,528.31**
Tilled Compost-Amended Turf (TCT)				
	Surface Preparation	$1.36/SF	2500 SF	$3,400.00
	Detention Volume	$4.50/CY	3.55 CY	$15.98
			Total	**$3,415.98**
			Difference	**$887.67**
			Per SF	**$0.36/SF**

8.0 GREEN ROOF

Green roofs are a building construction technique that includes soil and plant material in place of standard roofing systems. Green roofs typically consist of a waterproof membrane, root barrier, insulation, growth medium, and vegetation. Intensive green roofs consist of highly manicured landscape designs with turfs and shrubs. Intensive green roof also generally require irrigation and additional growth medium increasing the initial construction costs. For this project, the cost for an extensive green roof is used. Extensive green roofs consist of a thinner growth medium and the primary plant materials used are sedums which are adapted to growing in difficult conditions. This cost analysis is based on the initial construction costs and the realized savings in required stormwater management

facilities. Additional life-cycle cost savings may include reduced heating/cooling requirements, increased roof life, these not considered as part of this project. To determine stormwater management facility volume savings, the detention required for a standard roof modeled as impervious surface was compared to an extensive green roof assumed to have hydrologic characteristics comparable to grass/landscaping.

	Item	Unit Cost	Quantity	Cost
Standard Roof (Hot Applied Roofing)				
	Roofing	$10.00/SF	10,000 SF	$100,000.00
	Detention Volume	$4.50/CY	188.78 CY	$849.51
			Total	**$100,849.51**
Green Roof (Extensive)				
	Green Roof	$12.50/SF	10,000 SF	$125,000.00
	Detention Volume	$4.50/CY	56.48 CY	$254.16
			Total	**$125,254.16**
			Difference	**$24,404.65**
			Per SF	**$2.44/SF**

9.0 DETENTION FOR STANDARD RESIDENTIAL SUBDIVISION

AHBL has previously provided a case study for the Kensington Estates residential development. This study reviewed the stormwater detention and treatment requirements for a 24-acre residential subdivision located in Pierce County, Washington. Comparisons were made for multiple low impact development scenarios and were compared against a conventional development. This study is provided in Appendix G of this cost comparison.

10.0 CONCLUSION

This analysis is based on data and records either supplied to or obtained by AHBL. These documents are referenced within the text of the analysis. The analysis has been prepared using procedures and practices within the standard accepted practices of the industry.

AHBL, Inc.

Glenn C. Hume, PE
Project Engineer

GCH

APPENDIX A

WWHM Output for Infiltration Trenches vs. Bioretention Cells

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: trench
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.046

DEVELOPED LAND USE
Basin : Dev
Flows To : Trench
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.046

RCHRES (POND) INFORMATION
Pond Name: Trench
Pond Type: Table
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 0ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
35.00	0.001	0.000	0.000	0.031
35.10	0.001	0.000	0.000	0.031
35.20	0.001	0.000	0.000	0.031
35.30	0.001	0.000	0.000	0.031
35.40	0.001	0.000	0.000	0.031
35.50	0.001	0.000	0.000	0.031
35.60	0.001	0.000	0.000	0.031
35.70	0.001	0.000	0.000	0.031
35.80	0.001	0.000	0.000	0.031
35.90	0.001	0.000	0.000	0.031
36.00	0.001	0.000	0.000	0.031
36.10	0.001	0.000	0.000	0.031
36.20	0.001	0.000	0.000	0.031
36.30	0.001	0.000	0.000	0.031
36.40	0.001	0.000	0.000	0.031
36.50	0.001	0.000	0.000	0.031
36.60	0.001	0.000	0.000	0.031
36.70	0.001	0.001	0.000	0.031
36.80	0.001	0.001	0.000	0.031
36.90	0.001	0.001	0.000	0.031

37.00	0.001	0.001	0.000	0.031
37.10	0.001	0.001	0.000	0.031
37.20	0.001	0.001	0.000	0.031
37.30	0.001	0.001	0.000	0.031
37.40	0.001	0.001	0.000	0.031
37.50	0.001	0.001	0.000	0.031
37.60	0.001	0.001	0.000	0.031
37.70	0.001	0.001	0.000	0.031
37.80	0.001	0.001	0.000	0.031
37.90	0.001	0.001	0.000	0.031
38.00	0.001	0.001	0.000	0.031
38.10	0.001	0.001	0.308	0.031
38.20	0.001	0.001	0.871	0.031
38.30	0.001	0.001	1.600	0.031
38.40	0.001	0.001	2.464	0.031
38.50	0.001	0.001	3.443	0.031

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.001101
5 year	0.001846
10 year	0.002405
25 year	0.003176
50 year	0.003791
100 year	0.004438

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.014372
5 year	0.019186
10 year	0.022598
25 year	0.027174
50 year	0.030781
100 year	0.034562

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.116571
5 year	0.404998
10 year	0.854347
25 year	2.041729
50 year	3.739259
100 year	6.633062

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.002	0.000
1950	0.001	0.000
1951	0.003	0.000
1952	0.001	0.000
1953	0.001	0.000
1954	0.001	0.000
1955	0.001	0.000
1956	0.002	0.000
1957	0.001	0.000
1958	0.001	0.000
1959	0.001	0.000
1960	0.005	0.006
1961	0.001	0.000
1962	0.000	0.000
1963	0.003	0.000
1964	0.001	0.000
1965	0.001	0.000
1966	0.003	0.000
1967	0.001	0.000

1968	0.001	0.000
1969	0.001	0.000
1970	0.001	0.000
1971	0.001	0.000
1972	0.002	0.000
1973	0.001	0.000
1974	0.002	0.000
1975	0.001	0.000
1976	0.001	0.000
1977	0.000	0.000
1978	0.003	0.000
1979	0.001	0.000
1980	0.002	0.000
1981	0.001	0.000
1982	0.002	0.000
1983	0.001	0.000
1984	0.000	0.000
1985	0.001	0.000
1986	0.001	0.000
1987	0.003	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.001	0.000
1992	0.001	0.000
1993	0.002	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.001	0.000

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0032	0.0000
2	0.0030	0.0000
3	0.0028	0.0000
4	0.0027	0.0000
5	0.0025	0.0000
6	0.0021	0.0000
7	0.0018	0.0000
8	0.0017	0.0000
9	0.0017	0.0000
10	0.0016	0.0000
11	0.0015	0.0000
12	0.0015	0.0000
13	0.0015	0.0000
14	0.0015	0.0000
15	0.0014	0.0000
16	0.0014	0.0000
17	0.0014	0.0000
18	0.0013	0.0000
19	0.0013	0.0000
20	0.0013	0.0000
21	0.0013	0.0000
22	0.0012	0.0000
23	0.0012	0.0000
24	0.0012	0.0000
25	0.0010	0.0000
26	0.0010	0.0000
27	0.0010	0.0000
28	0.0010	0.0000
29	0.0009	0.0000
30	0.0009	0.0000
31	0.0008	0.0000
32	0.0008	0.0000
33	0.0008	0.0000
34	0.0008	0.0000
35	0.0007	0.0000
36	0.0007	0.0000
37	0.0007	0.0000
38	0.0007	0.0000
39	0.0006	0.0000

40	0.0006	0.0000
41	0.0006	0.0000
42	0.0006	0.0000
43	0.0005	0.0000
44	0.0004	0.0000
45	0.0004	0.0000
46	0.0004	0.0000
47	0.0002	0.0000

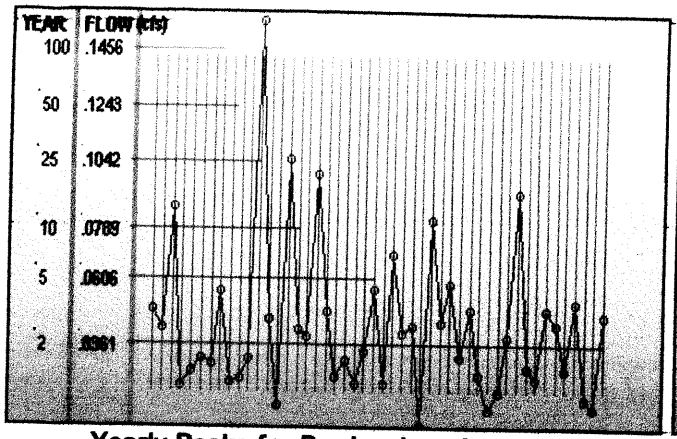
1/2 2 year to 50 year

Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0006	4176	2	.0	Pass
0.0006	3627	2	.0	Pass
0.0006	3168	2	.0	Pass
0.0006	2783	2	.0	Pass
0.0007	2464	2	.0	Pass
0.0007	2200	2	.0	Pass
0.0007	1996	2	.0	Pass
0.0008	1807	2	.0	Pass
0.0008	1620	2	.0	Pass
0.0008	1456	2	.0	Pass
0.0009	1313	2	.0	Pass
0.0009	1175	2	.0	Pass
0.0009	1054	2	.0	Pass
0.0010	937	2	.0	Pass
0.0010	843	2	.0	Pass
0.0010	746	2	.0	Pass
0.0011	667	2	.0	Pass
0.0011	603	2	.0	Pass
0.0011	543	2	.0	Pass
0.0012	480	2	.0	Pass
0.0012	432	2	.0	Pass
0.0012	378	2	.0	Pass
0.0013	332	2	.0	Pass
0.0013	293	2	.0	Pass
0.0013	261	2	.0	Pass
0.0014	236	2	.0	Pass
0.0014	210	2	.0	Pass
0.0014	184	2	1.0	Pass
0.0015	171	2	1.0	Pass
0.0015	158	2	1.0	Pass
0.0015	143	2	1.0	Pass
0.0016	129	2	1.0	Pass
0.0016	120	2	1.0	Pass
0.0016	114	2	1.0	Pass
0.0017	105	2	1.0	Pass
0.0017	95	2	2.0	Pass
0.0017	89	2	2.0	Pass
0.0018	80	2	2.0	Pass
0.0018	71	2	2.0	Pass
0.0018	65	2	3.0	Pass
0.0019	60	2	3.0	Pass
0.0019	56	2	3.0	Pass
0.0019	50	2	4.0	Pass
0.0020	47	2	4.0	Pass
0.0020	46	2	4.0	Pass
0.0020	42	2	4.0	Pass
0.0021	39	2	5.0	Pass
0.0021	36	2	5.0	Pass
0.0021	34	2	5.0	Pass
0.0022	31	2	6.0	Pass
0.0022	29	2	6.0	Pass
0.0022	26	2	7.0	Pass
0.0023	24	2	8.0	Pass
0.0023	23	2	8.0	Pass
0.0023	22	2	9.0	Pass
0.0024	18	2	11.0	Pass
0.0024	17	2	11.0	Pass
0.0024	14	2	14.0	Pass
0.0024	12	2	16.0	Pass
0.0025	10	2	20.0	Pass

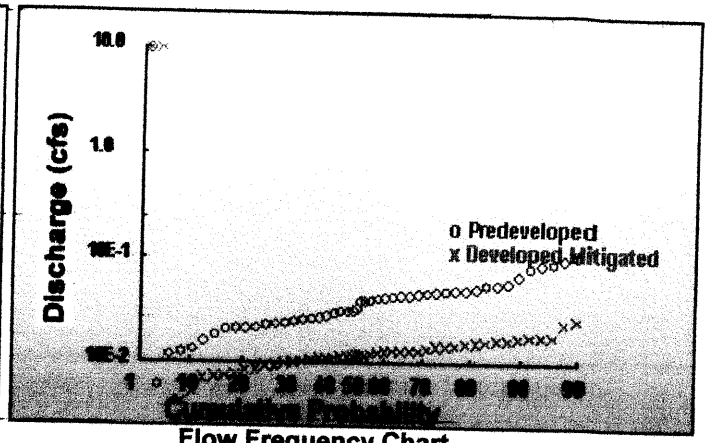
0.0025	10	2	20.0	Pass
0.0025	8	2	25.0	Pass
0.0026	8	2	25.0	Pass
0.0026	7	2	28.0	Pass
0.0026	7	2	28.0	Pass
0.0027	6	2	33.0	Pass
0.0027	5	2	40.0	Pass
0.0027	5	2	40.0	Pass
0.0028	5	2	40.0	Pass
0.0028	4	2	50.0	Pass
0.0028	3	2	66.0	Pass
0.0029	3	2	66.0	Pass
0.0029	3	2	66.0	Pass
0.0029	3	2	66.0	Pass
0.0030	3	2	66.0	Pass
0.0030	3	2	66.0	Pass
0.0030	2	2	100.0	Pass
0.0031	2	2	100.0	Pass
0.0031	2	2	100.0	Pass
0.0031	2	2	100.0	Pass
0.0032	2	2	100.0	Pass
0.0032	1	2	200.0	Fail
0.0032	1	2	200.0	Fail
0.0033	1	2	200.0	Fail
0.0033	1	2	200.0	Fail
0.0033	1	2	200.0	Fail
0.0034	1	2	200.0	Fail
0.0034	1	2	200.0	Fail
0.0034	1	2	200.0	Fail
0.0035	1	2	200.0	Fail
0.0035	1	2	200.0	Fail
0.0035	1	2	200.0	Fail
0.0036	1	2	200.0	Fail
0.0036	1	2	200.0	Fail
0.0036	1	2	200.0	Fail
0.0037	1	2	200.0	Fail
0.0037	1	2	200.0	Fail
0.0037	1	2	200.0	Fail
0.0038	1	2	200.0	Fail
0.0038	1	2	200.0	Fail

The development has an increase in flow durations from 1/2 predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

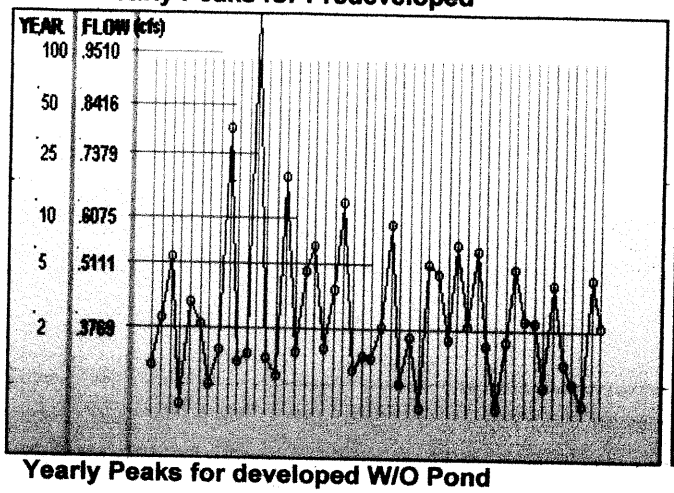
Water Quality BMP Flow and Volume.
On-line facility volume: 0.138 acre-feet
On-line facility target flow: 0.15 **cfs.**
Adjusted for 15 min: 0.17 **cfs.**
Off-line facility target flow: 0.09 **cfs.**
Adjusted for 15 min: 0.1 **cfs.**



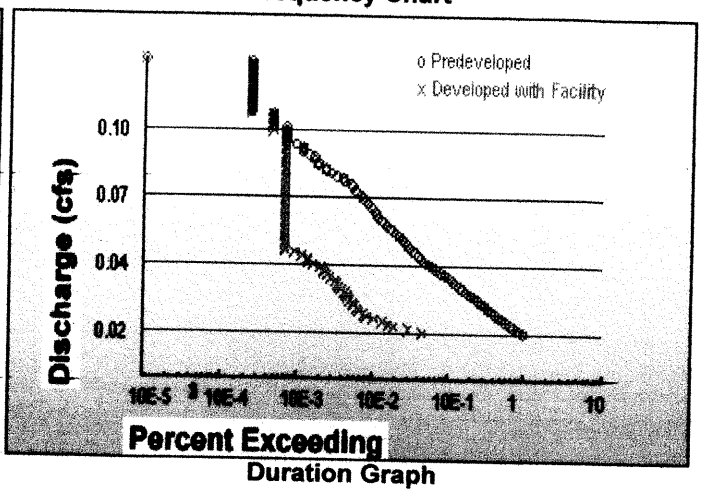
Yearly Peaks for Predeveloped



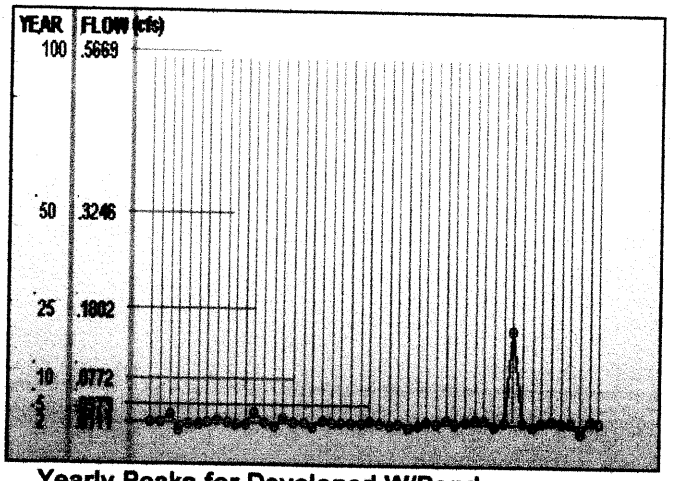
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: trench(till)
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.046

DEVELOPED LAND USE
Basin : Dev
Flows To : Trench(till)
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.046

RCHRES (POND) INFORMATION
Pond Name: Trench(till)
Pond Type: Table
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 0ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
35.00	0.007	0.000	0.000	0.007
35.10	0.007	0.000	0.000	0.007
35.20	0.007	0.000	0.000	0.007
35.30	0.007	0.001	0.000	0.007
35.40	0.007	0.001	0.000	0.007
35.50	0.007	0.001	0.000	0.007
35.60	0.007	0.001	0.000	0.007
35.70	0.007	0.001	0.000	0.007
35.80	0.007	0.002	0.000	0.007
35.90	0.007	0.002	0.000	0.007
36.00	0.007	0.002	0.000	0.007
36.10	0.007	0.002	0.000	0.007
36.20	0.007	0.002	0.000	0.007
36.30	0.007	0.003	0.000	0.007
36.40	0.007	0.003	0.000	0.007
36.50	0.007	0.003	0.000	0.007
36.60	0.007	0.003	0.000	0.007
36.70	0.007	0.004	0.000	0.007
36.80	0.007	0.004	0.000	0.007

37.00	0.007	0.004	0.000	0.007
37.10	0.007	0.004	0.000	0.007
37.20	0.007	0.005	0.000	0.007
37.30	0.007	0.005	0.000	0.007
37.40	0.007	0.005	0.000	0.007
37.50	0.007	0.005	0.000	0.007
37.60	0.007	0.005	0.000	0.007
37.70	0.007	0.006	0.000	0.007
37.80	0.007	0.006	0.000	0.007
37.90	0.007	0.006	0.000	0.007
38.00	0.007	0.006	0.000	0.007
38.10	0.007	0.006	0.308	0.007
38.20	0.007	0.007	0.871	0.007
38.30	0.007	0.007	1.600	0.007
38.40	0.007	0.007	2.464	0.007
38.50	0.007	0.007	3.443	0.007

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.001101
5 year	0.001846
10 year	0.002405
25 year	0.003176
50 year	0.003791
100 year	0.004438

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.014372
5 year	0.019186
10 year	0.022598
25 year	0.027174
50 year	0.030781
100 year	0.034562

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.008358
5 year	0.046501
10 year	0.130081
25 year	0.432149
50 year	0.994897
100 year	2.191918

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.002	0.000
1950	0.001	0.000
1951	0.003	0.000
1952	0.001	0.000
1953	0.001	0.000
1954	0.001	0.000
1955	0.001	0.000
1956	0.002	0.000
1957	0.001	0.000
1958	0.001	0.000
1959	0.001	0.000
1960	0.005	0.000
1961	0.001	0.000
1962	0.000	0.000
1963	0.003	0.000
1964	0.001	0.000
1965	0.001	0.000
1966	0.003	0.000
1967	0.001	0.000

1968	0.001	0.000
1969	0.001	0.000
1970	0.001	0.000
1971	0.001	0.000
1972	0.002	0.000
1973	0.001	0.000
1974	0.002	0.000
1975	0.001	0.000
1976	0.001	0.000
1977	0.000	0.000
1978	0.003	0.000
1979	0.001	0.000
1980	0.002	0.000
1981	0.001	0.000
1982	0.002	0.000
1983	0.001	0.000
1984	0.000	0.000
1985	0.001	0.000
1986	0.001	0.000
1987	0.003	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.001	0.000
1992	0.001	0.000
1993	0.002	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.001	0.000

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0032	0.0000
2	0.0030	0.0000
3	0.0028	0.0000
4	0.0027	0.0000
5	0.0025	0.0000
6	0.0021	0.0000
7	0.0018	0.0000
8	0.0017	0.0000
9	0.0017	0.0000
10	0.0016	0.0000
11	0.0015	0.0000
12	0.0015	0.0000
13	0.0015	0.0000
14	0.0015	0.0000
15	0.0014	0.0000
16	0.0014	0.0000
17	0.0014	0.0000
18	0.0013	0.0000
19	0.0013	0.0000
20	0.0013	0.0000
21	0.0013	0.0000
22	0.0012	0.0000
23	0.0012	0.0000
24	0.0012	0.0000
25	0.0010	0.0000
26	0.0010	0.0000
27	0.0010	0.0000
28	0.0010	0.0000
29	0.0009	0.0000
30	0.0009	0.0000
31	0.0008	0.0000
32	0.0008	0.0000
33	0.0008	0.0000
34	0.0008	0.0000
35	0.0007	0.0000
36	0.0007	0.0000
37	0.0007	0.0000
38	0.0007	0.0000
39	0.0006	0.0000

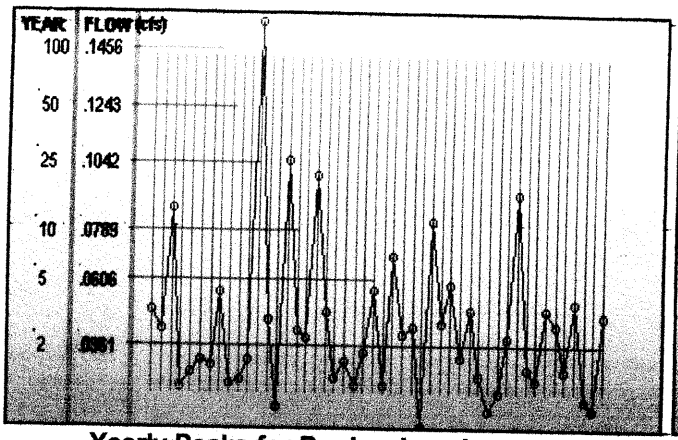
40	0.0006	0.0000
41	0.0006	0.0000
42	0.0006	0.0000
43	0.0005	0.0000
44	0.0004	0.0000
45	0.0004	0.0000
46	0.0004	0.0000
47	0.0002	0.0000

1/2 2 year to 50 year

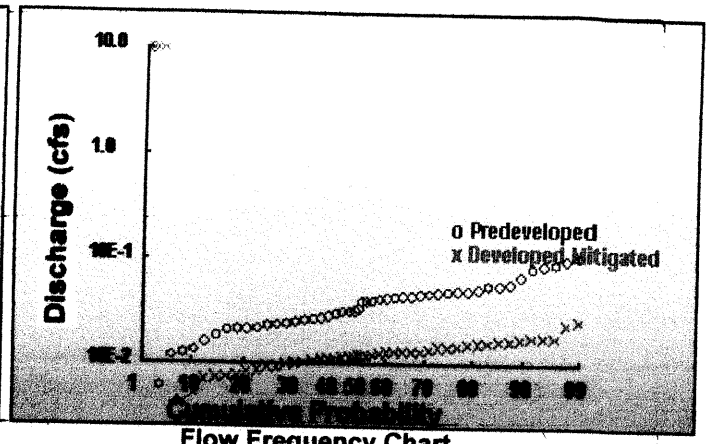
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0006	4176	0	.0	Pass
0.0006	3627	0	.0	Pass
0.0006	3168	0	.0	Pass
0.0006	2783	0	.0	Pass
0.0007	2464	0	.0	Pass
0.0007	2200	0	.0	Pass
0.0007	1996	0	.0	Pass
0.0008	1807	0	.0	Pass
0.0008	1620	0	.0	Pass
0.0008	1456	0	.0	Pass
0.0009	1313	0	.0	Pass
0.0009	1175	0	.0	Pass
0.0009	1054	0	.0	Pass
0.0010	937	0	.0	Pass
0.0010	843	0	.0	Pass
0.0010	746	0	.0	Pass
0.0011	667	0	.0	Pass
0.0011	603	0	.0	Pass
0.0011	543	0	.0	Pass
0.0012	480	0	.0	Pass
0.0012	432	0	.0	Pass
0.0012	378	0	.0	Pass
0.0013	332	0	.0	Pass
0.0013	293	0	.0	Pass
0.0013	261	0	.0	Pass
0.0014	236	0	.0	Pass
0.0014	210	0	.0	Pass
0.0014	184	0	.0	Pass
0.0015	171	0	.0	Pass
0.0015	158	0	.0	Pass
0.0015	143	0	.0	Pass
0.0016	129	0	.0	Pass
0.0016	120	0	.0	Pass
0.0016	114	0	.0	Pass
0.0017	105	0	.0	Pass
0.0017	95	0	.0	Pass
0.0017	89	0	.0	Pass
0.0018	80	0	.0	Pass
0.0018	71	0	.0	Pass
0.0018	65	0	.0	Pass
0.0019	60	0	.0	Pass
0.0019	56	0	.0	Pass
0.0019	50	0	.0	Pass
0.0020	47	0	.0	Pass
0.0020	46	0	.0	Pass
0.0020	42	0	.0	Pass
0.0021	39	0	.0	Pass
0.0021	36	0	.0	Pass
0.0021	34	0	.0	Pass
0.0022	31	0	.0	Pass
0.0022	29	0	.0	Pass
0.0022	26	0	.0	Pass
0.0023	24	0	.0	Pass
0.0023	23	0	.0	Pass
0.0023	22	0	.0	Pass
0.0024	18	0	.0	Pass
0.0024	17	0	.0	Pass
0.0024	14	0	.0	Pass
0.0024	12	0	.0	Pass
0.0025	10	0	.0	Pass

0.0025	10	0	.0	Pass
0.0025	8	0	.0	Pass
0.0026	8	0	.0	Pass
0.0026	7	0	.0	Pass
0.0026	7	0	.0	Pass
0.0027	6	0	.0	Pass
0.0027	5	0	.0	Pass
0.0027	5	0	.0	Pass
0.0028	5	0	.0	Pass
0.0028	4	0	.0	Pass
0.0028	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0030	3	0	.0	Pass
0.0030	3	0	.0	Pass
0.0030	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0032	2	0	.0	Pass
0.0032	1	0	.0	Pass
0.0032	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0038	1	0	.0	Pass
0.0038	1	0	.0	Pass

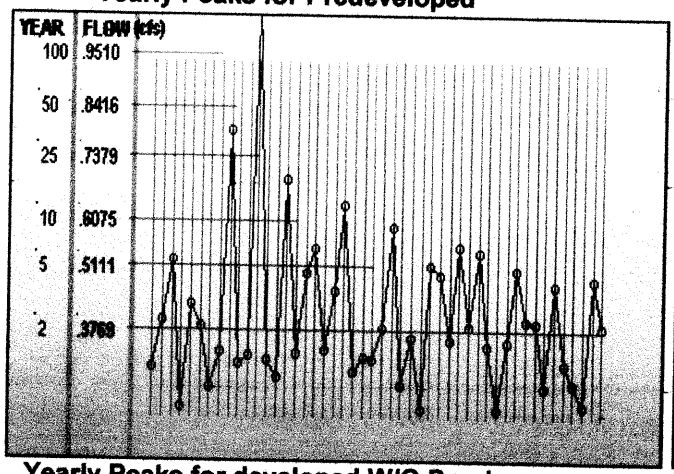
Water Quality BMP Flow and Volume.
On-line facility volume: 0.138 acre-feet
On-line facility target flow: 0.15 **cfs.**
Adjusted for 15 min: 0.17 **cfs.**
Off-line facility target flow: 0.09 **cfs.**
Adjusted for 15 min: 0.1 **cfs.**



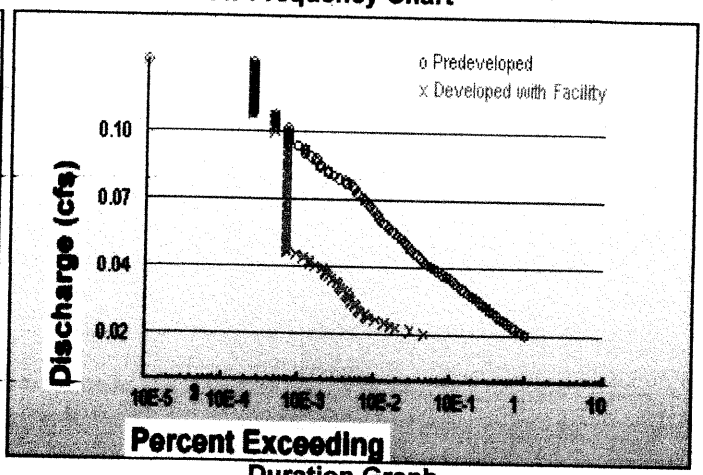
Yearly Peaks for Predeveloped



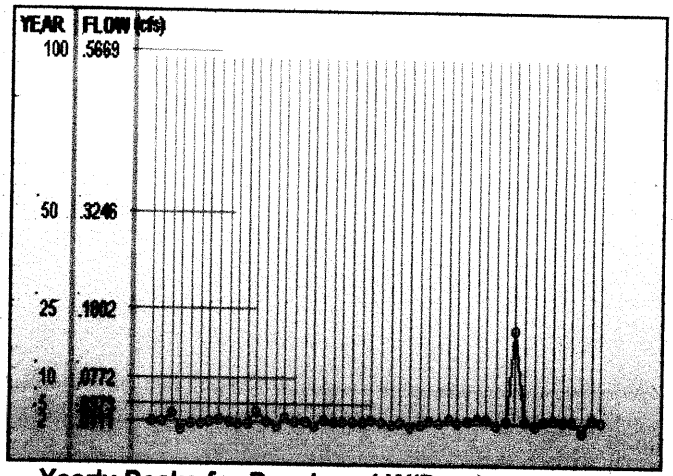
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: roof drain
Site Address:
City :
Report Date : 7/27/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.046

DEVELOPED LAND USE
Basin : Dev
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.046

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is activated.
Dimensions
Depth: 1ft.
Bottom Length: 45ft.
Bottom Width : 10ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.006 acre-ft.
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 12 in.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.010	0.000	0.000	0.000
0.044	0.011	0.000	0.000	0.011
0.089	0.011	0.001	0.000	0.011
0.133	0.011	0.001	0.000	0.012
0.178	0.012	0.002	0.000	0.012
0.222	0.012	0.002	0.000	0.012
0.267	0.012	0.003	0.000	0.013
0.311	0.013	0.004	0.000	0.013
0.356	0.013	0.004	0.000	0.013

0.400	0.013	0.005	0.000	0.014
0.444	0.014	0.005	0.000	0.014
0.489	0.014	0.006	0.000	0.015
0.533	0.015	0.007	0.059	0.015
0.578	0.015	0.007	0.211	0.015
0.622	0.015	0.008	0.416	0.016
0.667	0.016	0.009	0.663	0.016
0.711	0.016	0.009	0.945	0.017
0.756	0.017	0.010	1.258	0.017
0.800	0.017	0.011	1.600	0.017
0.844	0.017	0.012	1.969	0.018
0.889	0.018	0.012	2.362	0.018
0.933	0.018	0.013	2.778	0.019
0.978	0.019	0.014	3.216	0.019
1.022	0.019	0.015	3.675	0.020

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.001101
5 year	0.001846
10 year	0.002405
25 year	0.003176
50 year	0.003791
100 year	0.004438

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.014372
5 year	0.019186
10 year	0.022598
25 year	0.027174
50 year	0.030781
100 year	0.034562

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.00757
5 year	0.010085
10 year	0.01194
25 year	0.014508
50 year	0.016591
100 year	0.018825

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.002	0.000
1950	0.001	0.000
1951	0.003	0.000
1952	0.001	0.000
1953	0.001	0.000
1954	0.001	0.000
1955	0.001	0.000
1956	0.002	0.000
1957	0.001	0.000
1958	0.001	0.000
1959	0.001	0.000
1960	0.005	0.000
1961	0.001	0.000
1962	0.000	0.000
1963	0.003	0.000
1964	0.001	0.000
1965	0.001	0.000
1966	0.003	0.000
1967	0.001	0.000
1968	0.001	0.000

1969	0.001	0.000
1970	0.001	0.000
1971	0.001	0.000
1972	0.002	0.000
1973	0.001	0.000
1974	0.002	0.000
1975	0.001	0.000
1976	0.001	0.000
1977	0.000	0.000
1978	0.003	0.000
1979	0.001	0.000
1980	0.002	0.000
1981	0.001	0.000
1982	0.002	0.000
1983	0.001	0.000
1984	0.000	0.000
1985	0.001	0.000
1986	0.001	0.000
1987	0.003	0.000
1988	0.001	0.000
1989	0.001	0.000
1990	0.001	0.000
1991	0.001	0.000
1992	0.001	0.000
1993	0.002	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.001	0.000

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0032	0.0000
2	0.0030	0.0000
3	0.0028	0.0000
4	0.0027	0.0000
5	0.0025	0.0000
6	0.0021	0.0000
7	0.0018	0.0000
8	0.0017	0.0000
9	0.0017	0.0000
10	0.0016	0.0000
11	0.0015	0.0000
12	0.0015	0.0000
13	0.0015	0.0000
14	0.0015	0.0000
15	0.0014	0.0000
16	0.0014	0.0000
17	0.0014	0.0000
18	0.0013	0.0000
19	0.0013	0.0000
20	0.0013	0.0000
21	0.0013	0.0000
22	0.0012	0.0000
23	0.0012	0.0000
24	0.0012	0.0000
25	0.0010	0.0000
26	0.0010	0.0000
27	0.0010	0.0000
28	0.0010	0.0000
29	0.0009	0.0000
30	0.0009	0.0000
31	0.0008	0.0000
32	0.0008	0.0000
33	0.0008	0.0000
34	0.0008	0.0000
35	0.0007	0.0000
36	0.0007	0.0000
37	0.0007	0.0000
38	0.0007	0.0000
39	0.0006	0.0000
40	0.0006	0.0000

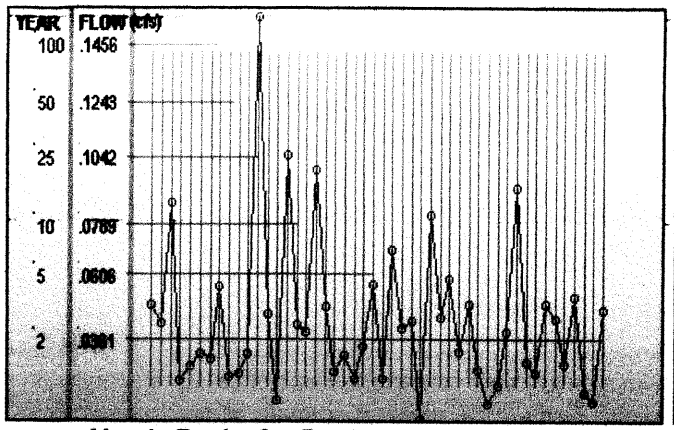
41	0.0006	0.0000
42	0.0006	0.0000
43	0.0005	0.0000
44	0.0004	0.0000
45	0.0004	0.0000
46	0.0004	0.0000
47	0.0002	0.0000

1/2 2 year to 50 year

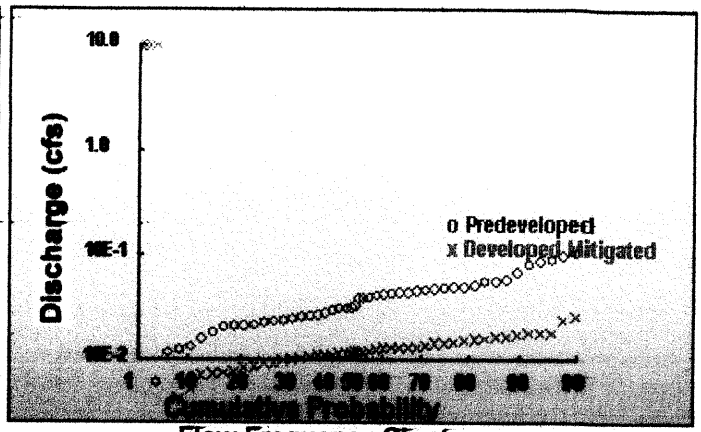
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0006	4176	0	.0	Pass
0.0006	3627	0	.0	Pass
0.0006	3168	0	.0	Pass
0.0006	2783	0	.0	Pass
0.0007	2464	0	.0	Pass
0.0007	2200	0	.0	Pass
0.0007	1996	0	.0	Pass
0.0008	1807	0	.0	Pass
0.0008	1620	0	.0	Pass
0.0008	1456	0	.0	Pass
0.0009	1313	0	.0	Pass
0.0009	1175	0	.0	Pass
0.0009	1054	0	.0	Pass
0.0010	937	0	.0	Pass
0.0010	843	0	.0	Pass
0.0010	746	0	.0	Pass
0.0011	667	0	.0	Pass
0.0011	603	0	.0	Pass
0.0011	543	0	.0	Pass
0.0012	480	0	.0	Pass
0.0012	432	0	.0	Pass
0.0012	378	0	.0	Pass
0.0013	332	0	.0	Pass
0.0013	293	0	.0	Pass
0.0013	261	0	.0	Pass
0.0014	236	0	.0	Pass
0.0014	210	0	.0	Pass
0.0014	184	0	.0	Pass
0.0015	171	0	.0	Pass
0.0015	158	0	.0	Pass
0.0015	143	0	.0	Pass
0.0016	129	0	.0	Pass
0.0016	120	0	.0	Pass
0.0016	114	0	.0	Pass
0.0017	105	0	.0	Pass
0.0017	95	0	.0	Pass
0.0017	89	0	.0	Pass
0.0018	80	0	.0	Pass
0.0018	71	0	.0	Pass
0.0018	65	0	.0	Pass
0.0019	60	0	.0	Pass
0.0019	56	0	.0	Pass
0.0019	50	0	.0	Pass
0.0020	47	0	.0	Pass
0.0020	46	0	.0	Pass
0.0020	42	0	.0	Pass
0.0021	39	0	.0	Pass
0.0021	36	0	.0	Pass
0.0021	34	0	.0	Pass
0.0022	31	0	.0	Pass
0.0022	29	0	.0	Pass
0.0022	26	0	.0	Pass
0.0023	24	0	.0	Pass
0.0023	23	0	.0	Pass
0.0023	22	0	.0	Pass
0.0024	18	0	.0	Pass
0.0024	17	0	.0	Pass
0.0024	14	0	.0	Pass
0.0024	12	0	.0	Pass
0.0025	10	0	.0	Pass
0.0025	10	0	.0	Pass

0.0025	8	0	.0	Pass
0.0026	8	0	.0	Pass
0.0026	7	0	.0	Pass
0.0026	7	0	.0	Pass
0.0027	6	0	.0	Pass
0.0027	5	0	.0	Pass
0.0027	5	0	.0	Pass
0.0028	5	0	.0	Pass
0.0028	4	0	.0	Pass
0.0028	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0029	3	0	.0	Pass
0.0030	3	0	.0	Pass
0.0030	3	0	.0	Pass
0.0030	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0031	2	0	.0	Pass
0.0032	2	0	.0	Pass
0.0032	1	0	.0	Pass
0.0032	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0033	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0034	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0035	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0036	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0037	1	0	.0	Pass
0.0038	1	0	.0	Pass
0.0038	1	0	.0	Pass

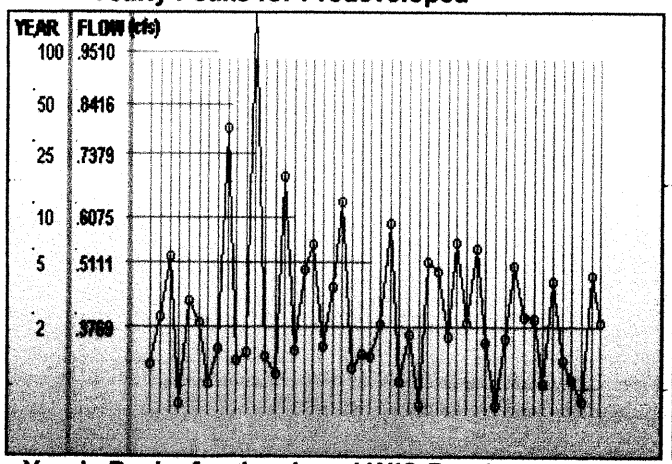
Water Quality BMP Flow and Volume.
On-line facility volume: 0.109 acre-feet
On-line facility target flow: 0.11 **cfs.**
Adjusted for 15 min: 0.11 **cfs.**
Off-line facility target flow: 0.06 **cfs.**
Adjusted for 15 min: 0.06 **cfs.**



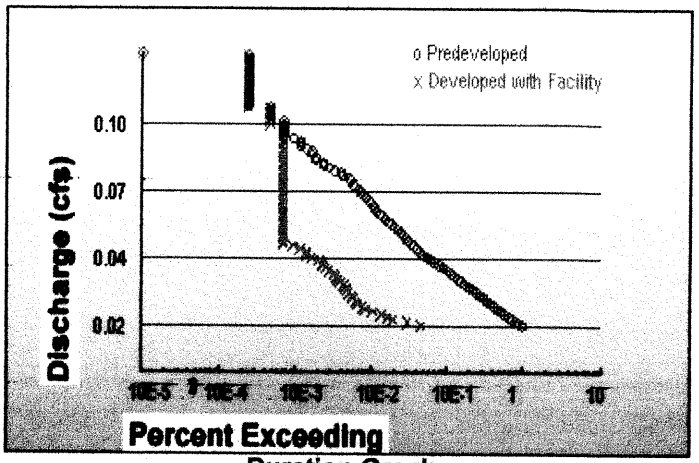
Yearly Peaks for Predeveloped



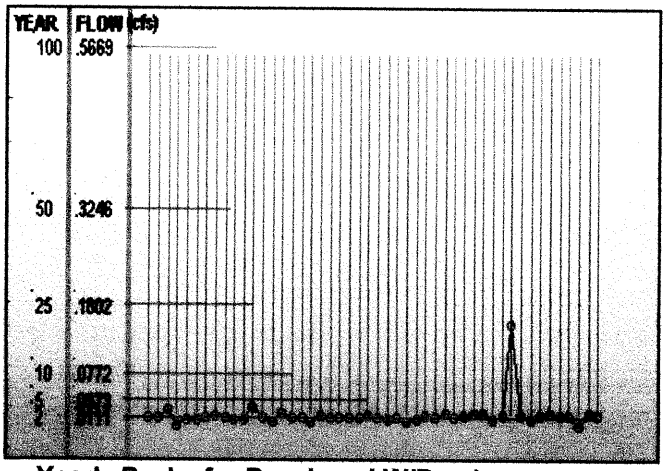
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: driveway(trench)
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.011

DEVELOPED LAND USE
Basin : Dev
Flows To : Trench(driveway)
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.011

RCHRES (POND) INFORMATION
Pond Name: Trench(driveway)
Pond Type: Table
Pond Flows to : Point of Compliance
Pond Rain / Evap is activated.
Dimensions
Depth: 0ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
35.00	0.000	0.000	0.000	0.010
35.10	0.000	0.000	0.000	0.010
35.20	0.000	0.000	0.000	0.010
35.30	0.000	0.000	0.000	0.010
35.40	0.000	0.000	0.000	0.010
35.50	0.000	0.000	0.000	0.010
35.60	0.000	0.000	0.000	0.010
35.70	0.000	0.000	0.000	0.010
35.80	0.000	0.000	0.000	0.010
35.90	0.000	0.000	0.000	0.010
36.00	0.000	0.000	0.000	0.010
36.10	0.000	0.000	0.000	0.010
36.20	0.000	0.000	0.000	0.010
36.30	0.000	0.000	0.000	0.010
36.40	0.000	0.000	0.000	0.010
36.50	0.000	0.000	0.000	0.010
36.60	0.000	0.000	0.000	0.010
36.70	0.000	0.000	0.000	0.010
36.80	0.000	0.000	0.000	0.010

37.00	0.000	0.000	0.000	0.010
37.10	0.000	0.000	0.000	0.010
37.20	0.000	0.000	0.000	0.010
37.30	0.000	0.000	0.000	0.010
37.40	0.000	0.000	0.000	0.010
37.50	0.000	0.000	0.000	0.010
37.60	0.000	0.000	0.000	0.010
37.70	0.000	0.000	0.000	0.010
37.80	0.000	0.000	0.000	0.010
37.90	0.000	0.000	0.000	0.010
38.00	0.000	0.000	0.000	0.010
38.10	0.000	0.000	0.308	0.010
38.20	0.000	0.000	0.871	0.010
38.30	0.000	0.000	1.600	0.010
38.40	0.000	0.000	2.464	0.010
38.50	0.000	0.000	3.443	0.010

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.001101
5 year	0.001846
10 year	0.002405
25 year	0.003176
50 year	0.003791
100 year	0.004438

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.002874
5 year	0.003837
10 year	0.00452
25 year	0.005435
50 year	0.006156
100 year	0.006912

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.017331
5 year	0.027632
10 year	0.035445
25 year	0.046409
50 year	0.055355
100 year	0.064962

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.000	0.000
1950	0.000	0.000
1951	0.001	0.000
1952	0.000	0.000
1953	0.000	0.000
1954	0.000	0.000
1955	0.000	0.000
1956	0.000	0.000
1957	0.000	0.000
1958	0.000	0.000
1959	0.000	0.000
1960	0.001	0.000
1961	0.000	0.000
1962	0.000	0.000
1963	0.001	0.000
1964	0.000	0.000
1965	0.000	0.000
1966	0.001	0.000
1967	0.000	0.000

1968	0.000	0.000
1969	0.000	0.000
1970	0.000	0.000
1971	0.000	0.000
1972	0.000	0.000
1973	0.000	0.000
1974	0.000	0.000
1975	0.000	0.000
1976	0.000	0.000
1977	0.000	0.000
1978	0.001	0.000
1979	0.000	0.000
1980	0.000	0.000
1981	0.000	0.000
1982	0.000	0.000
1983	0.000	0.000
1984	0.000	0.000
1985	0.000	0.000
1986	0.000	0.000
1987	0.001	0.000
1988	0.000	0.000
1989	0.000	0.000
1990	0.000	0.000
1991	0.000	0.000
1992	0.000	0.000
1993	0.000	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.000	0.000

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0006	0.0000
2	0.0006	0.0000
3	0.0006	0.0000
4	0.0005	0.0000
5	0.0005	0.0000
6	0.0004	0.0000
7	0.0004	0.0000
8	0.0003	0.0000
9	0.0003	0.0000
10	0.0003	0.0000
11	0.0003	0.0000
12	0.0003	0.0000
13	0.0003	0.0000
14	0.0003	0.0000
15	0.0003	0.0000
16	0.0003	0.0000
17	0.0003	0.0000
18	0.0003	0.0000
19	0.0003	0.0000
20	0.0003	0.0000
21	0.0003	0.0000
22	0.0002	0.0000
23	0.0002	0.0000
24	0.0002	0.0000
25	0.0002	0.0000
26	0.0002	0.0000
27	0.0002	0.0000
28	0.0002	0.0000
29	0.0002	0.0000
30	0.0002	0.0000
31	0.0002	0.0000
32	0.0002	0.0000
33	0.0002	0.0000
34	0.0002	0.0000
35	0.0001	0.0000
36	0.0001	0.0000
37	0.0001	0.0000
38	0.0001	0.0000
39	0.0001	0.0000

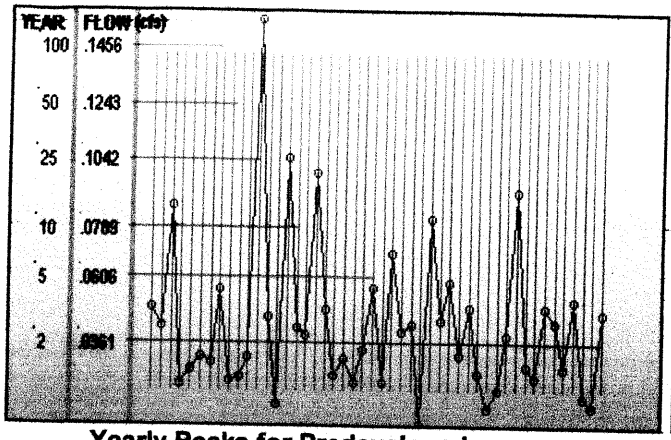
40	0.0001	0.0000
41	0.0001	0.0000
42	0.0001	0.0000
43	0.0001	0.0000
44	0.0001	0.0000
45	0.0001	0.0000
46	0.0001	0.0000
47	0.0000	0.0000

1/2 2 year to 50 year

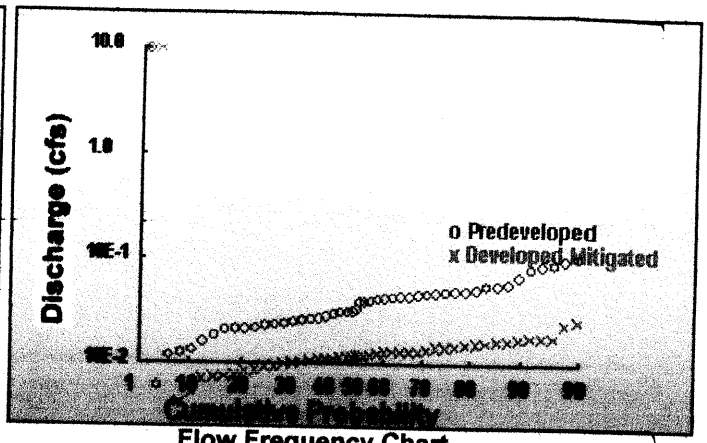
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0006	5	0	.0	Pass
0.0006	3	0	.0	Pass
0.0006	2	0	.0	Pass
0.0006	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0010	0	0	.0	Pass
0.0010	0	0	.0	Pass
0.0010	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0025	0	0	.0	Pass

0.0025	0	0	.0	Pass
0.0025	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0038	0	0	.0	Pass
0.0038	0	0	.0	Pass

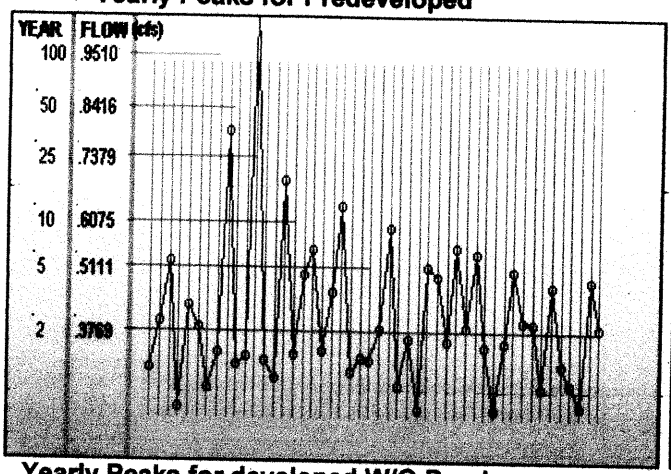
Water Quality BMP Flow and Volume.
On-line facility volume: 0.109 acre-feet
On-line facility target flow: 0.11 **cfs.**
Adjusted for 15 min: 0.11 **cfs.**
Off-line facility target flow: 0.06 **cfs.**
Adjusted for 15 min: 0.06 **cfs.**



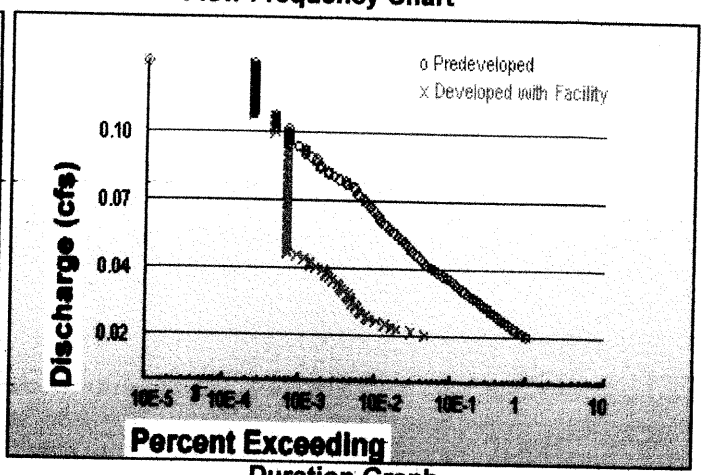
Yearly Peaks for Predeveloped



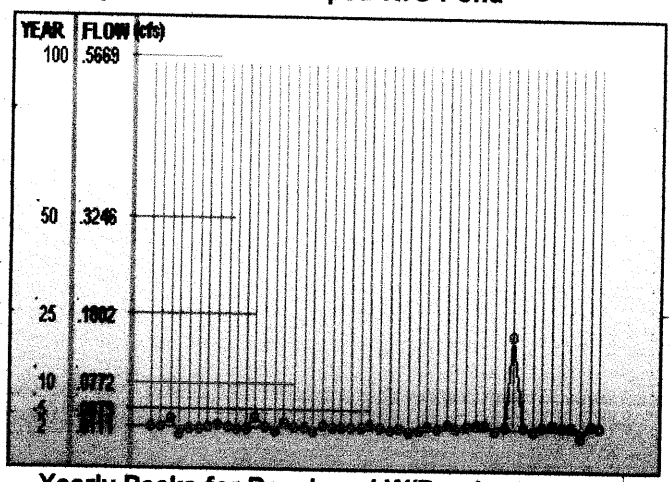
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: driveway
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.011

DEVELOPED LAND USE
Basin : Dev
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.011

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is activated.
Dimensions
Depth: 1ft.
Bottom Length: 15ft.
Bottom Width : 4.5ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.001 acre-ft.
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 12 in.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.002	0.000	0.000	0.000
0.044	0.002	0.000	0.000	0.002
0.089	0.002	0.000	0.000	0.002
0.133	0.002	0.000	0.000	0.002
0.178	0.002	0.000	0.000	0.002
0.222	0.002	0.000	0.000	0.002
0.267	0.002	0.001	0.000	0.002
0.311	0.002	0.001	0.000	0.003
0.356	0.003	0.001	0.000	0.003

0.400	0.003	0.001	0.000	0.003
0.444	0.003	0.001	0.000	0.003
0.489	0.003	0.001	0.000	0.003
0.533	0.003	0.001	0.059	0.003
0.578	0.003	0.001	0.211	0.004
0.622	0.004	0.002	0.416	0.004
0.667	0.004	0.002	0.663	0.004
0.711	0.004	0.002	0.945	0.004
0.756	0.004	0.002	1.258	0.004
0.800	0.004	0.002	1.600	0.004
0.844	0.004	0.002	1.969	0.005
0.889	0.005	0.003	2.362	0.005
0.933	0.005	0.003	2.778	0.005
0.978	0.005	0.003	3.216	0.005
1.022	0.005	0.003	3.675	0.005

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.001101
5 year	0.001846
10 year	0.002405
25 year	0.003176
50 year	0.003791
100 year	0.004438

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.002874
5 year	0.003837
10 year	0.00452
25 year	0.005435
50 year	0.006156
100 year	0.006912

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.00757
5 year	0.010085
10 year	0.01194
25 year	0.014508
50 year	0.016591
100 year	0.018825

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.000	0.000
1950	0.000	0.000
1951	0.001	0.000
1952	0.000	0.000
1953	0.000	0.000
1954	0.000	0.000
1955	0.000	0.000
1956	0.000	0.000
1957	0.000	0.000
1958	0.000	0.000
1959	0.000	0.000
1960	0.001	0.000
1961	0.000	0.000
1962	0.000	0.000
1963	0.001	0.000
1964	0.000	0.000
1965	0.000	0.000
1966	0.001	0.000
1967	0.000	0.000
1968	0.000	0.000

1969	0.000	0.000
1970	0.000	0.000
1971	0.000	0.000
1972	0.000	0.000
1973	0.000	0.000
1974	0.000	0.000
1975	0.000	0.000
1976	0.000	0.000
1977	0.000	0.000
1978	0.001	0.000
1979	0.000	0.000
1980	0.000	0.000
1981	0.000	0.000
1982	0.000	0.000
1983	0.000	0.000
1984	0.000	0.000
1985	0.000	0.000
1986	0.000	0.000
1987	0.001	0.000
1988	0.000	0.000
1989	0.000	0.000
1990	0.000	0.000
1991	0.000	0.000
1992	0.000	0.000
1993	0.000	0.000
1994	0.000	0.000
1995	0.000	0.000
1996	0.000	0.000

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0006	0.0000
2	0.0006	0.0000
3	0.0006	0.0000
4	0.0005	0.0000
5	0.0005	0.0000
6	0.0004	0.0000
7	0.0004	0.0000
8	0.0003	0.0000
9	0.0003	0.0000
10	0.0003	0.0000
11	0.0003	0.0000
12	0.0003	0.0000
13	0.0003	0.0000
14	0.0003	0.0000
15	0.0003	0.0000
16	0.0003	0.0000
17	0.0003	0.0000
18	0.0003	0.0000
19	0.0003	0.0000
20	0.0003	0.0000
21	0.0003	0.0000
22	0.0002	0.0000
23	0.0002	0.0000
24	0.0002	0.0000
25	0.0002	0.0000
26	0.0002	0.0000
27	0.0002	0.0000
28	0.0002	0.0000
29	0.0002	0.0000
30	0.0002	0.0000
31	0.0002	0.0000
32	0.0002	0.0000
33	0.0002	0.0000
34	0.0002	0.0000
35	0.0001	0.0000
36	0.0001	0.0000
37	0.0001	0.0000
38	0.0001	0.0000
39	0.0001	0.0000
40	0.0001	0.0000

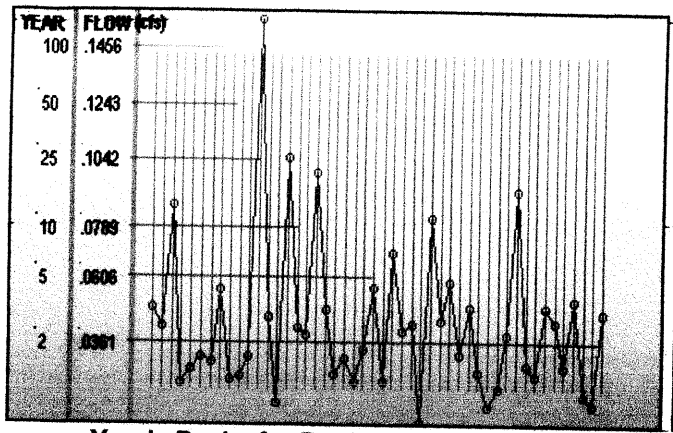
41	0.0001	0.0000
42	0.0001	0.0000
43	0.0001	0.0000
44	0.0001	0.0000
45	0.0001	0.0000
46	0.0001	0.0000
47	0.0000	0.0000

1/2 2 year to 50 year

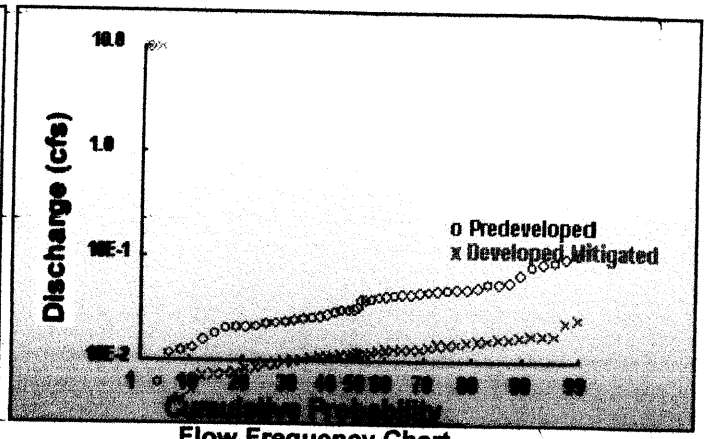
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0006	5	0	.0	Pass
0.0006	3	0	.0	Pass
0.0006	2	0	.0	Pass
0.0006	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0007	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0008	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0009	1	0	.0	Pass
0.0010	0	0	.0	Pass
0.0010	0	0	.0	Pass
0.0010	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0011	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0012	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0013	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0014	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0015	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0016	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0017	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0018	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0019	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0020	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0021	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0022	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0023	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0024	0	0	.0	Pass
0.0025	0	0	.0	Pass
0.0025	0	0	.0	Pass

0.0025	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0026	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0027	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0028	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0029	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0030	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0031	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0032	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0033	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0034	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0035	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0036	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0037	0	0	.0	Pass
0.0038	0	0	.0	Pass
0.0038	0	0	.0	Pass

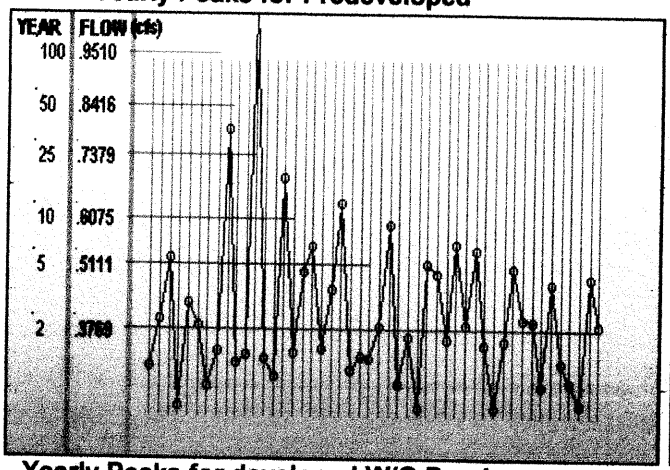
Water Quality BMP Flow and Volume.
On-line facility volume: 0.109 acre-feet
On-line facility target flow: 0.11 **cfs.**
Adjusted for 15 min: 0.11 **cfs.**
Off-line facility target flow: 0.06 **cfs.**
Adjusted for 15 min: 0.06 **cfs.**



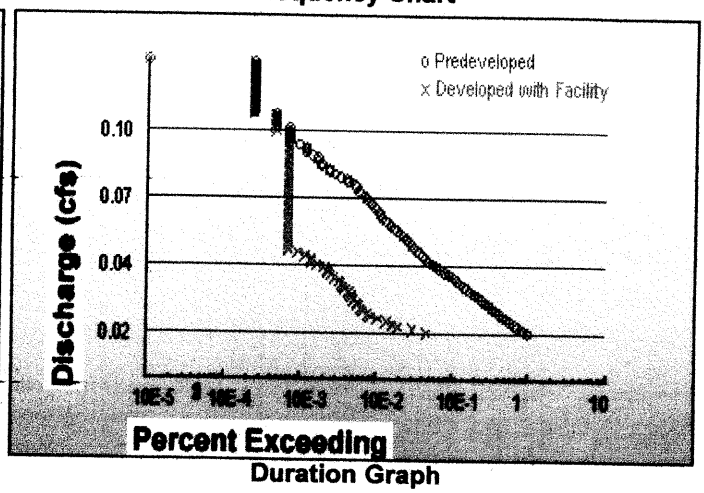
Yearly Peaks for Predeveloped



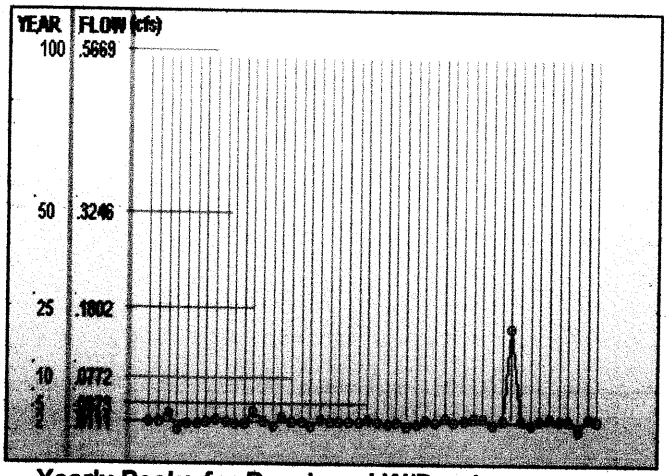
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX B

WWHM Output for 24’ Standard Road vs. LID Road Section

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: 24' standard road
Site Address:
City :
Report Date : 6/9/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	1.64

DEVELOPED LAND USE
Basin : Dev
Flows To : Pond 1
GroundWater: No

Land Use	Acres
TILL GRASS:	0.492
IMPERVIOUS:	1.148

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 4ft.
Bottom Length: 148.2ft.
Bottom Width : 49.41ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.634 acre-ft. 27617 CF → 1023 cy
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.018 ft.
Notch Height: 1.155 ft.
Orifice 1 Diameter: 0.71104 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.168	0.000	0.000	0.000
0.044	0.169	0.007	0.003	0.000
0.089	0.171	0.015	0.004	0.000
0.133	0.172	0.023	0.005	0.000

0.178	0.173	0.030	0.006	0.000
0.222	0.174	0.038	0.006	0.000
0.267	0.175	0.046	0.007	0.000
0.311	0.177	0.054	0.007	0.000
0.356	0.178	0.062	0.008	0.000
0.400	0.179	0.069	0.008	0.000
0.444	0.180	0.077	0.009	0.000
0.489	0.182	0.085	0.009	0.000
0.533	0.183	0.094	0.010	0.000
0.578	0.184	0.102	0.010	0.000
0.622	0.185	0.110	0.010	0.000
0.667	0.187	0.118	0.011	0.000
0.711	0.188	0.127	0.011	0.000
0.756	0.189	0.135	0.012	0.000
0.800	0.190	0.143	0.012	0.000
0.844	0.192	0.152	0.012	0.000
0.889	0.193	0.160	0.013	0.000
0.933	0.194	0.169	0.013	0.000
0.978	0.196	0.178	0.013	0.000
1.022	0.197	0.186	0.013	0.000
1.067	0.198	0.195	0.014	0.000
1.111	0.199	0.204	0.014	0.000
1.156	0.201	0.213	0.014	0.000
1.200	0.202	0.222	0.015	0.000
1.244	0.203	0.231	0.015	0.000
1.289	0.205	0.240	0.015	0.000
1.333	0.206	0.249	0.015	0.000
1.378	0.207	0.258	0.016	0.000
1.422	0.208	0.267	0.016	0.000
1.467	0.210	0.277	0.016	0.000
1.511	0.211	0.286	0.016	0.000
1.556	0.212	0.295	0.017	0.000
1.600	0.214	0.305	0.017	0.000
1.644	0.215	0.314	0.017	0.000
1.689	0.216	0.324	0.017	0.000
1.733	0.218	0.334	0.017	0.000
1.778	0.219	0.343	0.018	0.000
1.822	0.220	0.353	0.018	0.000
1.867	0.222	0.363	0.018	0.000
1.911	0.223	0.373	0.019	0.000
1.956	0.224	0.383	0.021	0.000
2.000	0.226	0.393	0.022	0.000
2.044	0.227	0.403	0.024	0.000
2.089	0.229	0.413	0.026	0.000
2.133	0.230	0.423	0.028	0.000
2.178	0.231	0.433	0.030	0.000
2.222	0.233	0.444	0.032	0.000
2.267	0.234	0.454	0.035	0.000
2.311	0.235	0.465	0.037	0.000
2.356	0.237	0.475	0.040	0.000
2.400	0.238	0.486	0.042	0.000
2.444	0.240	0.496	0.045	0.000
2.489	0.241	0.507	0.047	0.000
2.533	0.242	0.518	0.050	0.000
2.578	0.244	0.528	0.053	0.000
2.622	0.245	0.539	0.056	0.000
2.667	0.247	0.550	0.058	0.000
2.711	0.248	0.561	0.061	0.000
2.756	0.249	0.572	0.064	0.000
2.800	0.251	0.583	0.067	0.000
2.844	0.252	0.595	0.070	0.000
2.889	0.254	0.606	0.073	0.000
2.933	0.255	0.617	0.076	0.000
2.978	0.256	0.629	0.080	0.000
3.022	0.258	0.640	0.130	0.000
3.067	0.259	0.651	0.333	0.000
3.111	0.261	0.663	0.623	0.000
3.156	0.262	0.675	0.978	0.000
3.200	0.264	0.686	1.389	0.000
3.244	0.265	0.698	1.848	0.000
3.289	0.267	0.710	2.351	0.000
3.333	0.268	0.722	2.894	0.000

3.378	0.269	0.734	3.475	0.000
3.422	0.271	0.746	4.091	0.000
3.467	0.272	0.758	4.740	0.000
3.511	0.274	0.770	5.421	0.000
3.556	0.275	0.782	6.133	0.000
3.600	0.277	0.794	6.873	0.000
3.644	0.278	0.807	7.641	0.000
3.689	0.280	0.819	8.437	0.000
3.733	0.281	0.832	9.258	0.000
3.778	0.283	0.844	10.10	0.000
3.822	0.284	0.857	10.98	0.000
3.867	0.286	0.869	11.87	0.000
3.911	0.287	0.882	12.79	0.000
3.956	0.289	0.895	13.73	0.000
4.000	0.290	0.908	14.69	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.036097
5 year	0.060553
10 year	0.078894
25 year	0.104157
50 year	0.124334
100 year	0.145571

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.358405
5 year	0.48822
10 year	0.581688
25 year	0.708592
50 year	0.809687
100 year	0.91654

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.02198
5 year	0.033886
10 year	0.043924
25 year	0.059457
50 year	0.073374
100 year	0.089549

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.050	0.020
1950	0.042	0.020
1951	0.087	0.062
1952	0.021	0.013
1953	0.026	0.039
1954	0.031	0.017
1955	0.029	0.013
1956	0.056	0.045
1957	0.022	0.016
1958	0.023	0.015
1959	0.031	0.020
1960	0.155	0.038
1961	0.046	0.061
1962	0.014	0.014
1963	0.105	0.023
1964	0.041	0.022
1965	0.039	0.019
1966	0.099	0.017
1967	0.048	0.017
1968	0.024	0.016

1969	0.030	0.018
1970	0.021	0.027
1971	0.033	0.022
1972	0.057	0.049
1973	0.021	0.027
1974	0.070	0.018
1975	0.040	0.022
1976	0.043	0.023
1977	0.006	0.018
1978	0.083	0.023
1979	0.045	0.016
1980	0.059	0.050
1981	0.032	0.027
1982	0.049	0.045
1983	0.025	0.016
1984	0.012	0.017
1985	0.018	0.020
1986	0.039	0.017
1987	0.092	0.100
1988	0.027	0.019
1989	0.023	0.019
1990	0.049	0.050
1991	0.044	0.017
1992	0.027	0.018
1993	0.052	0.016
1994	0.016	0.015
1995	0.013	0.018
1996	0.047	0.040

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.1047	0.0621
2	0.0994	0.0606
3	0.0924	0.0502
4	0.0870	0.0500
5	0.0825	0.0494
6	0.0698	0.0453
7	0.0588	0.0446
8	0.0566	0.0401
9	0.0559	0.0395
10	0.0521	0.0384
11	0.0495	0.0271
12	0.0494	0.0271
13	0.0490	0.0268
14	0.0483	0.0233
15	0.0471	0.0232
16	0.0457	0.0229
17	0.0445	0.0224
18	0.0440	0.0220
19	0.0432	0.0216
20	0.0424	0.0201
21	0.0415	0.0199
22	0.0402	0.0197
23	0.0392	0.0197
24	0.0390	0.0194
25	0.0333	0.0187
26	0.0316	0.0187
27	0.0312	0.0180
28	0.0312	0.0178
29	0.0302	0.0178
30	0.0286	0.0178
31	0.0275	0.0176
32	0.0265	0.0173
33	0.0261	0.0171
34	0.0250	0.0170
35	0.0243	0.0170
36	0.0235	0.0168
37	0.0233	0.0168
38	0.0218	0.0165
39	0.0212	0.0161
40	0.0212	0.0159

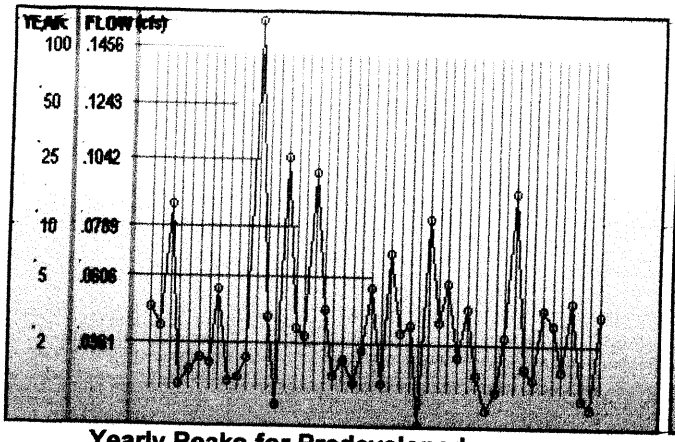
41	0.0210	0.0157
42	0.0185	0.0156
43	0.0159	0.0149
44	0.0135	0.0146
45	0.0126	0.0145
46	0.0119	0.0132
47	0.0062	0.0130

1/2 2 year to 50 year

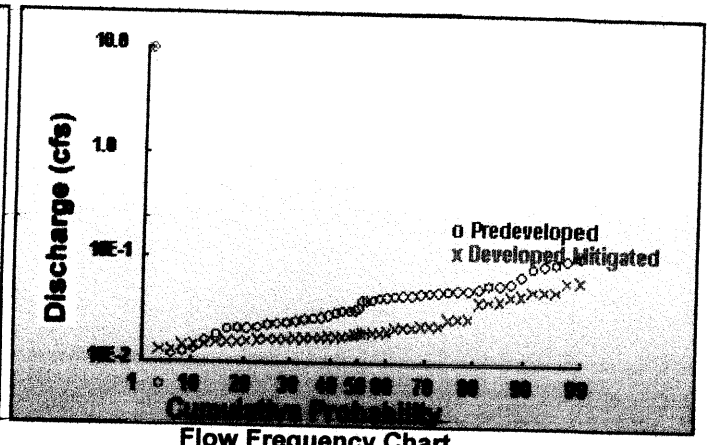
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0180	4176	4173	99.0	Pass
0.0191	3628	3053	84.0	Pass
0.0202	3166	2556	80.0	Pass
0.0213	2780	2258	81.0	Pass
0.0223	2463	1959	79.0	Pass
0.0234	2202	1730	78.0	Pass
0.0245	1991	1573	79.0	Pass
0.0256	1805	1437	79.0	Pass
0.0266	1620	1307	80.0	Pass
0.0277	1456	1200	82.0	Pass
0.0288	1310	1105	84.0	Pass
0.0299	1174	1015	86.0	Pass
0.0309	1054	953	90.0	Pass
0.0320	937	889	94.0	Pass
0.0331	842	814	96.0	Pass
0.0342	746	743	99.0	Pass
0.0352	667	665	99.0	Pass
0.0363	603	601	99.0	Pass
0.0374	542	514	94.0	Pass
0.0384	480	414	86.0	Pass
0.0395	432	347	80.0	Pass
0.0406	378	311	82.0	Pass
0.0417	332	281	84.0	Pass
0.0427	293	255	87.0	Pass
0.0438	261	230	88.0	Pass
0.0449	236	195	82.0	Pass
0.0460	209	173	82.0	Pass
0.0470	184	143	77.0	Pass
0.0481	171	126	73.0	Pass
0.0492	157	108	68.0	Pass
0.0503	143	88	61.0	Pass
0.0513	129	83	64.0	Pass
0.0524	120	77	64.0	Pass
0.0535	114	71	62.0	Pass
0.0546	105	67	63.0	Pass
0.0556	95	62	65.0	Pass
0.0567	89	54	60.0	Pass
0.0578	80	50	62.0	Pass
0.0588	72	44	61.0	Pass
0.0599	65	38	58.0	Pass
0.0610	60	31	51.0	Pass
0.0621	56	27	48.0	Pass
0.0631	50	23	46.0	Pass
0.0642	47	22	46.0	Pass
0.0653	46	20	43.0	Pass
0.0664	42	19	45.0	Pass
0.0674	39	17	43.0	Pass
0.0685	36	16	44.0	Pass
0.0696	34	15	44.0	Pass
0.0707	31	14	45.0	Pass
0.0717	29	13	44.0	Pass
0.0728	26	11	42.0	Pass
0.0739	24	10	41.0	Pass
0.0749	23	9	39.0	Pass
0.0760	22	8	36.0	Pass
0.0771	18	7	38.0	Pass
0.0782	17	6	35.0	Pass
0.0792	14	5	35.0	Pass
0.0803	12	4	33.0	Pass
0.0814	10	4	40.0	Pass
0.0825	10	4	40.0	Pass

0.0835	8	4	50.0	Pass
0.0846	8	4	50.0	Pass
0.0857	7	4	57.0	Pass
0.0868	7	2	28.0	Pass
0.0878	6	2	33.0	Pass
0.0889	5	2	40.0	Pass
0.0900	5	2	40.0	Pass
0.0911	5	2	40.0	Pass
0.0921	4	2	50.0	Pass
0.0932	3	2	66.0	Pass
0.0943	3	2	66.0	Pass
0.0953	3	2	66.0	Pass
0.0964	3	2	66.0	Pass
0.0975	3	2	66.0	Pass
0.0986	3	1	33.0	Pass
0.0996	2	1	50.0	Pass
0.1007	2	0	.0	Pass
0.1018	2	0	.0	Pass
0.1029	2	0	.0	Pass
0.1039	2	0	.0	Pass
0.1050	1	0	.0	Pass
0.1061	1	0	.0	Pass
0.1072	1	0	.0	Pass
0.1082	1	0	.0	Pass
0.1093	1	0	.0	Pass
0.1104	1	0	.0	Pass
0.1115	1	0	.0	Pass
0.1125	1	0	.0	Pass
0.1136	1	0	.0	Pass
0.1147	1	0	.0	Pass
0.1157	1	0	.0	Pass
0.1168	1	0	.0	Pass
0.1179	1	0	.0	Pass
0.1190	1	0	.0	Pass
0.1200	1	0	.0	Pass
0.1211	1	0	.0	Pass
0.1222	1	0	.0	Pass
0.1233	1	0	.0	Pass
0.1243	1	0	.0	Pass

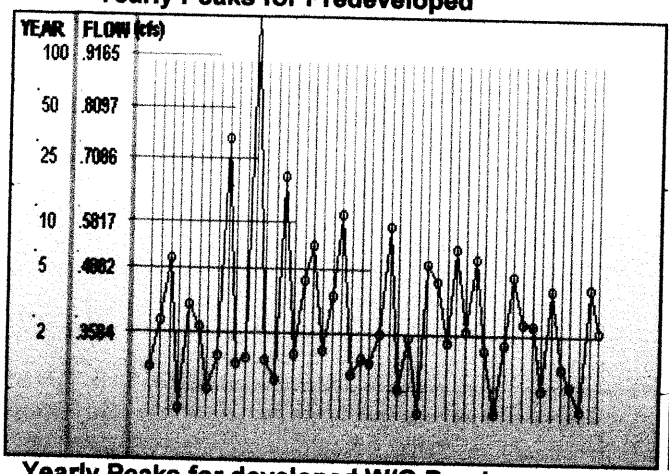
Water Quality BMP Flow and Volume.
On-line facility volume: 0.138 acre-feet
On-line facility target flow: 0.15 **cfs.**
Adjusted for 15 min: 0.17 **cfs.**
Off-line facility target flow: 0.09 **cfs.**
Adjusted for 15 min: 0.1 **cfs.**



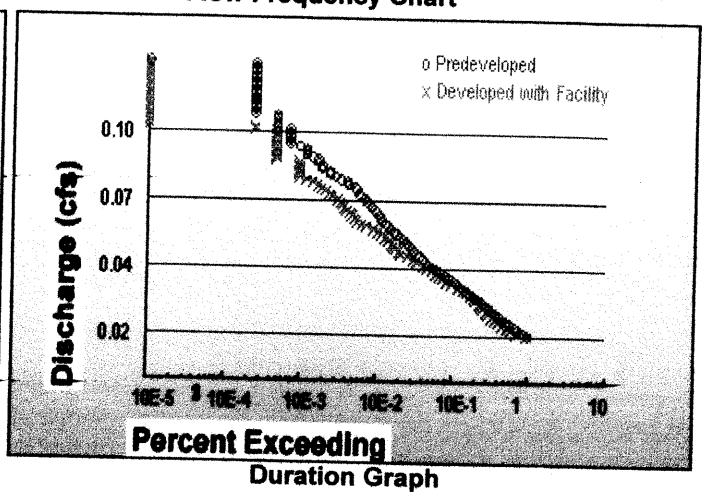
Yearly Peaks for Predeveloped



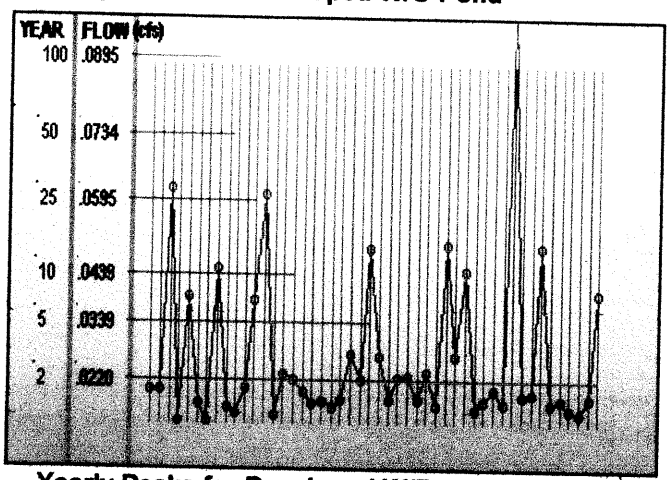
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: LID Road Section
Site Address:
City :
Report Date : 7/27/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	1.64

DEVELOPED LAND USE
Basin : Dev
Flows To : BR Swale
GroundWater: No

Land Use	Acres
TILL GRASS:	0.41
IMPERVIOUS:	1.23

RCHRES (POND) INFORMATION
Pond Name: BR Swale
Pond Type: Trapezoidal Pond
Pond Flows to : Pond 2
~~Pond Rain / Evap is not activated.~~
Dimensions
Depth: 1ft.
Bottom Length: 720ft.
Bottom Width : 4ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
~~Side slope 3:~~ 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.046 acre-ft.
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 12 in.

96.8% of runoff infiltrated through swale

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.066	0.000	0.000	0.000
0.100	0.076	0.007	0.000	0.067
0.200	0.086	0.015	0.000	0.067
0.300	0.096	0.024	0.000	0.067
0.400	0.106	0.034	0.000	0.067
0.500	0.116	0.046	0.000	0.067
0.600	0.126	0.058	0.308	0.067
0.700	0.136	0.071	0.871	0.067

0.800	0.146	0.085	1.600	0.067
0.900	0.157	0.100	2.464	0.067
1.000	0.167	0.116	3.443	0.067

Pond Name: Pond 2
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 4ft.
Bottom Length: 80.92ft.
Bottom Width : 26.98ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.225 acre-ft. 9801 CF → 363 cy
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 1.032 ft.
Orifice 1 Diameter: 0.729 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.050	0.000	0.000	0.000
0.044	0.051	0.002	0.003	0.000
0.089	0.051	0.005	0.004	0.000
0.133	0.052	0.007	0.005	0.000
0.178	0.053	0.009	0.006	0.000
0.222	0.053	0.012	0.007	0.000
0.267	0.054	0.014	0.007	0.000
0.311	0.055	0.016	0.008	0.000
0.356	0.056	0.019	0.008	0.000
0.400	0.056	0.021	0.009	0.000
0.444	0.057	0.024	0.009	0.000
0.489	0.058	0.026	0.010	0.000
0.533	0.058	0.029	0.010	0.000
0.578	0.059	0.031	0.011	0.000
0.622	0.060	0.034	0.011	0.000
0.667	0.060	0.037	0.011	0.000
0.711	0.061	0.039	0.012	0.000
0.756	0.062	0.042	0.012	0.000
0.800	0.063	0.045	0.012	0.000
0.844	0.063	0.048	0.013	0.000
0.889	0.064	0.051	0.013	0.000
0.933	0.065	0.053	0.013	0.000
0.978	0.065	0.056	0.014	0.000
1.022	0.066	0.059	0.014	0.000
1.067	0.067	0.062	0.014	0.000
1.111	0.068	0.065	0.015	0.000
1.156	0.068	0.068	0.015	0.000
1.200	0.069	0.071	0.015	0.000
1.244	0.070	0.074	0.016	0.000
1.289	0.071	0.078	0.016	0.000
1.333	0.071	0.081	0.016	0.000
1.378	0.072	0.084	0.016	0.000
1.422	0.073	0.087	0.017	0.000
1.467	0.074	0.090	0.017	0.000
1.511	0.074	0.094	0.017	0.000
1.556	0.075	0.097	0.017	0.000
1.600	0.076	0.100	0.018	0.000
1.644	0.077	0.104	0.018	0.000
1.689	0.078	0.107	0.018	0.000
1.733	0.078	0.111	0.018	0.000
1.778	0.079	0.114	0.019	0.000
1.822	0.080	0.118	0.019	0.000
1.867	0.081	0.121	0.019	0.000

1.911	0.082	0.125	0.019	0.000
1.956	0.082	0.128	0.020	0.000
2.000	0.083	0.132	0.020	0.000
2.044	0.084	0.136	0.021	0.000
2.089	0.085	0.140	0.022	0.000
2.133	0.086	0.143	0.023	0.000
2.178	0.086	0.147	0.024	0.000
2.222	0.087	0.151	0.025	0.000
2.267	0.088	0.155	0.026	0.000
2.311	0.089	0.159	0.027	0.000
2.356	0.090	0.163	0.029	0.000
2.400	0.091	0.167	0.030	0.000
2.444	0.091	0.171	0.032	0.000
2.489	0.092	0.175	0.033	0.000
2.533	0.093	0.179	0.035	0.000
2.578	0.094	0.183	0.036	0.000
2.622	0.095	0.187	0.038	0.000
2.667	0.096	0.192	0.040	0.000
2.711	0.096	0.196	0.041	0.000
2.756	0.097	0.200	0.043	0.000
2.800	0.098	0.205	0.044	0.000
2.844	0.099	0.209	0.046	0.000
2.889	0.100	0.213	0.048	0.000
2.933	0.101	0.218	0.049	0.000
2.978	0.102	0.222	0.051	0.000
3.022	0.103	0.227	0.101	0.000
3.067	0.103	0.232	0.304	0.000
3.111	0.104	0.236	0.594	0.000
3.156	0.105	0.241	0.949	0.000
3.200	0.106	0.246	1.360	0.000
3.244	0.107	0.250	1.819	0.000
3.289	0.108	0.255	2.322	0.000
3.333	0.109	0.260	2.865	0.000
3.378	0.110	0.265	3.446	0.000
3.422	0.111	0.270	4.062	0.000
3.467	0.112	0.275	4.711	0.000
3.511	0.112	0.280	5.392	0.000
3.556	0.113	0.285	6.103	0.000
3.600	0.114	0.290	6.844	0.000
3.644	0.115	0.295	7.612	0.000
3.689	0.116	0.300	8.407	0.000
3.733	0.117	0.305	9.229	0.000
3.778	0.118	0.310	10.08	0.000
3.822	0.119	0.316	10.95	0.000
3.867	0.120	0.321	11.84	0.000
3.911	0.121	0.326	12.76	0.000
3.956	0.122	0.332	13.70	0.000
4.000	0.123	0.337	14.66	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.036097
5 year	0.060553
10 year	0.078894
25 year	0.104157
50 year	0.124334
100 year	0.145571

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.376885
5 year	0.511138
10 year	0.607475
25 year	0.737928
50 year	0.841609
100 year	0.950993

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.011117
5 year	0.03734
10 year	0.07719
25 year	0.180161
50 year	0.324577
100 year	0.566883

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.050	0.012
1950	0.042	0.012
1951	0.087	0.024
1952	0.021	0.000
1953	0.026	0.007
1954	0.031	0.010
1955	0.029	0.010
1956	0.056	0.015
1957	0.022	0.012
1958	0.023	0.007
1959	0.031	0.009
1960	0.155	0.026
1961	0.046	0.011
1962	0.014	0.005
1963	0.105	0.017
1964	0.041	0.012
1965	0.039	0.012
1966	0.099	0.004
1967	0.048	0.013
1968	0.024	0.011
1969	0.030	0.011
1970	0.021	0.011
1971	0.033	0.011
1972	0.057	0.014
1973	0.021	0.010
1974	0.070	0.008
1975	0.040	0.012
1976	0.043	0.007
1977	0.006	0.009
1978	0.083	0.016
1979	0.045	0.013
1980	0.059	0.018
1981	0.032	0.011
1982	0.049	0.013
1983	0.025	0.018
1984	0.012	0.018
1985	0.018	0.009
1986	0.039	0.015
1987	0.092	0.151
1988	0.027	0.014
1989	0.023	0.008
1990	0.049	0.015
1991	0.044	0.018
1992	0.027	0.013
1993	0.052	0.016
1994	0.016	0.000
1995	0.013	0.017
1996	0.047	0.013

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.1047	0.0259
2	0.0994	0.0239
3	0.0924	0.0182
4	0.0870	0.0181
5	0.0825	0.0181
6	0.0698	0.0176
7	0.0588	0.0170
8	0.0566	0.0168

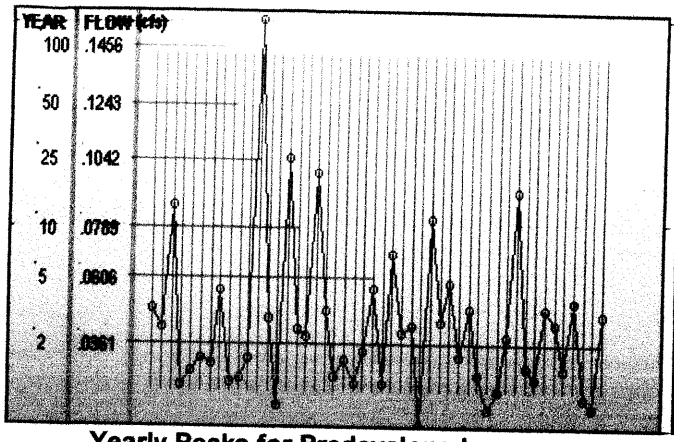
9	0.0559	0.0159
10	0.0521	0.0157
11	0.0495	0.0154
12	0.0494	0.0150
13	0.0490	0.0146
14	0.0483	0.0145
15	0.0471	0.0136
16	0.0457	0.0132
17	0.0445	0.0132
18	0.0440	0.0131
19	0.0432	0.0130
20	0.0424	0.0128
21	0.0415	0.0125
22	0.0402	0.0120
23	0.0392	0.0119
24	0.0390	0.0119
25	0.0333	0.0118
26	0.0316	0.0118
27	0.0312	0.0114
28	0.0312	0.0113
29	0.0302	0.0113
30	0.0286	0.0111
31	0.0275	0.0110
32	0.0265	0.0107
33	0.0261	0.0104
34	0.0250	0.0102
35	0.0243	0.0098
36	0.0235	0.0093
37	0.0233	0.0093
38	0.0218	0.0086
39	0.0212	0.0085
40	0.0212	0.0076
41	0.0210	0.0075
42	0.0185	0.0073
43	0.0159	0.0070
44	0.0135	0.0052
45	0.0126	0.0042
46	0.0119	0.0001
47	0.0062	0.0000

1/2 2 year to 50 year

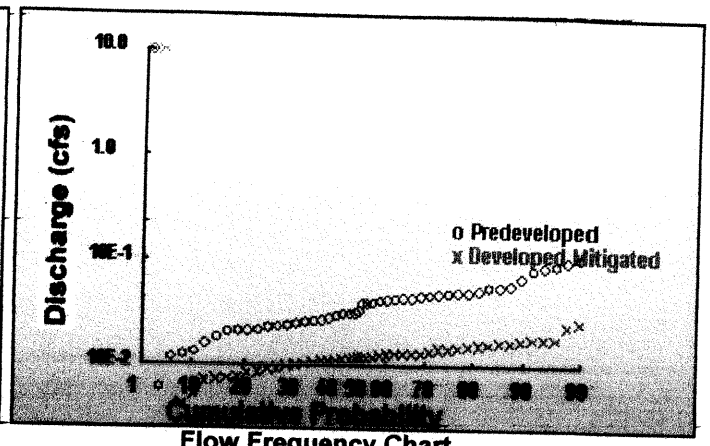
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0180	4176	195	4.0	Pass
0.0191	3628	125	3.0	Pass
0.0202	3166	83	2.0	Pass
0.0213	2780	71	2.0	Pass
0.0223	2463	59	2.0	Pass
0.0234	2202	45	2.0	Pass
0.0245	1991	36	1.0	Pass
0.0256	1805	33	1.0	Pass
0.0266	1620	28	1.0	Pass
0.0277	1456	27	1.0	Pass
0.0288	1310	25	1.0	Pass
0.0299	1174	24	2.0	Pass
0.0309	1054	22	2.0	Pass
0.0320	937	21	2.0	Pass
0.0331	842	20	2.0	Pass
0.0342	746	19	2.0	Pass
0.0352	667	17	2.0	Pass
0.0363	603	16	2.0	Pass
0.0374	542	15	2.0	Pass
0.0384	480	14	2.0	Pass
0.0395	432	12	2.0	Pass
0.0406	378	11	2.0	Pass
0.0417	332	10	3.0	Pass
0.0427	293	10	3.0	Pass
0.0438	261	9	3.0	Pass
0.0449	236	7	2.0	Pass
0.0460	209	6	2.0	Pass
0.0470	184	6	3.0	Pass
0.0481	171	5	2.0	Pass

0.0492	157	4	2.0	Pass
0.0503	143	3	2.0	Pass
0.0513	129	3	2.0	Pass
0.0524	120	3	2.0	Pass
0.0535	114	3	2.0	Pass
0.0546	105	3	2.0	Pass
0.0556	95	3	3.0	Pass
0.0567	89	3	3.0	Pass
0.0578	80	3	3.0	Pass
0.0588	72	3	4.0	Pass
0.0599	65	3	4.0	Pass
0.0610	60	3	5.0	Pass
0.0621	56	3	5.0	Pass
0.0631	50	3	6.0	Pass
0.0642	47	3	6.0	Pass
0.0653	46	3	6.0	Pass
0.0664	42	3	7.0	Pass
0.0674	39	3	7.0	Pass
0.0685	36	3	8.0	Pass
0.0696	34	3	8.0	Pass
0.0707	31	3	9.0	Pass
0.0717	29	3	10.0	Pass
0.0728	26	3	11.0	Pass
0.0739	24	3	12.0	Pass
0.0749	23	3	13.0	Pass
0.0760	22	3	13.0	Pass
0.0771	18	3	16.0	Pass
0.0782	17	3	17.0	Pass
0.0792	14	3	21.0	Pass
0.0803	12	3	25.0	Pass
0.0814	10	3	30.0	Pass
0.0825	10	3	30.0	Pass
0.0835	8	3	37.0	Pass
0.0846	8	3	37.0	Pass
0.0857	7	3	42.0	Pass
0.0868	7	3	42.0	Pass
0.0878	6	3	50.0	Pass
0.0889	5	3	60.0	Pass
0.0900	5	3	60.0	Pass
0.0911	5	3	60.0	Pass
0.0921	4	3	75.0	Pass
0.0932	3	3	100.0	Pass
0.0943	3	3	100.0	Pass
0.0953	3	3	100.0	Pass
0.0964	3	3	100.0	Pass
0.0975	3	2	66.0	Pass
0.0986	3	2	66.0	Pass
0.0996	2	2	100.0	Pass
0.1007	2	2	100.0	Pass
0.1018	2	2	100.0	Pass
0.1029	2	2	100.0	Pass
0.1039	2	1	50.0	Pass
0.1050	1	1	100.0	Pass
0.1061	1	1	100.0	Pass
0.1072	1	1	100.0	Pass
0.1082	1	1	100.0	Pass
0.1093	1	1	100.0	Pass
0.1104	1	1	100.0	Pass
0.1115	1	1	100.0	Pass
0.1125	1	1	100.0	Pass
0.1136	1	1	100.0	Pass
0.1147	1	1	100.0	Pass
0.1157	1	1	100.0	Pass
0.1168	1	1	100.0	Pass
0.1179	1	1	100.0	Pass
0.1190	1	1	100.0	Pass
0.1200	1	1	100.0	Pass
0.1211	1	1	100.0	Pass
0.1222	1	1	100.0	Pass
0.1233	1	1	100.0	Pass
0.1243	1	1	100.0	Pass

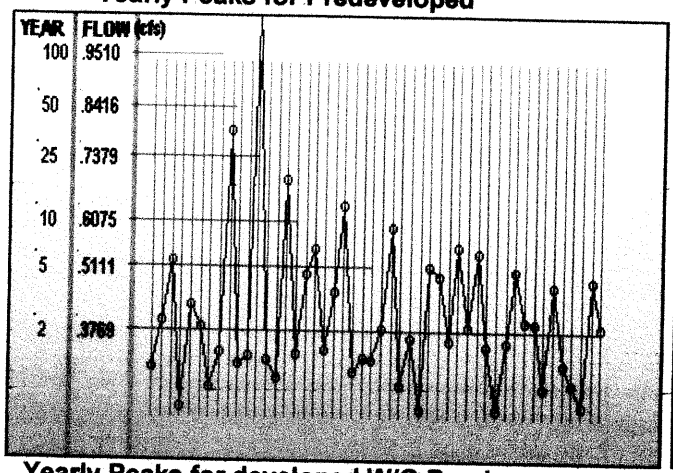
~~Water Quality~~ ~~BMP~~ Flow and Volume.
On-line facility volume: 0.138 acre-feet
On-line facility target flow: 0.15 **cfs.**
Adjusted for 15 min: 0.17 **cfs.**
~~Off-line facility target flow:~~ 0.09 **~~cfs.~~**
Adjusted for 15 min: 0.1 **cfs.**



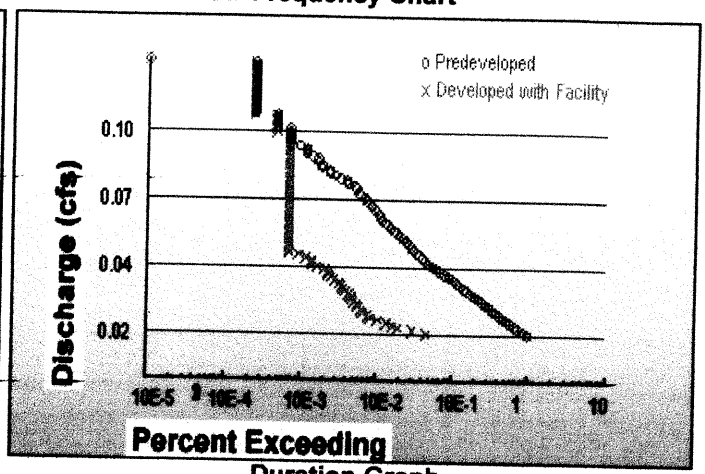
Yearly Peaks for Predeveloped



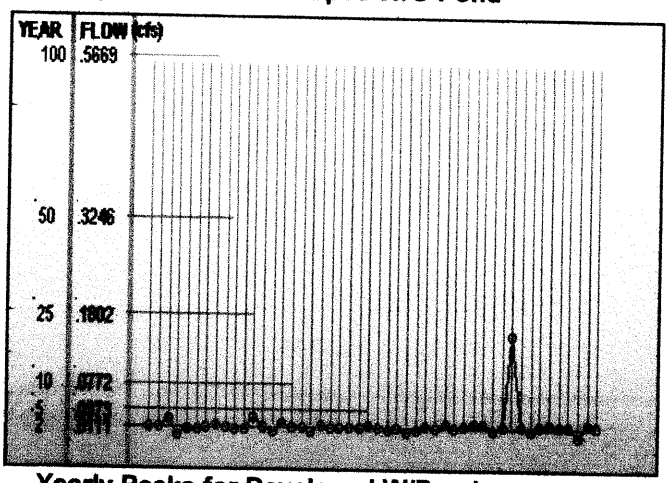
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX C

WWHM Output for Impervious Pavement vs. Pervious Pavement Modeled as Grass

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: impervious
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Basin 1
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.5

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.5

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 69.39ft.
Bottom Width : 23.12ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.267 acre-ft. 11630 CF / 21780 = 0.534 CF/SF → 0.02 CF/SF
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 0.876 ft.
Orifice 1 Diameter: 0.337 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.037	0.000	0.000	0.000
0.056	0.038	0.002	0.001	0.000
0.111	0.038	0.004	0.001	0.000
0.167	0.039	0.006	0.001	0.000
0.222	0.040	0.009	0.001	0.000

0.278	0.040	0.011	0.002	0.000
0.333	0.041	0.013	0.002	0.000
0.389	0.042	0.015	0.002	0.000
0.444	0.043	0.018	0.002	0.000
0.500	0.043	0.020	0.002	0.000
0.556	0.044	0.022	0.002	0.000
0.611	0.045	0.025	0.002	0.000
0.667	0.046	0.027	0.002	0.000
0.722	0.046	0.030	0.003	0.000
0.778	0.047	0.033	0.003	0.000
0.833	0.048	0.035	0.003	0.000
0.889	0.049	0.038	0.003	0.000
0.944	0.050	0.041	0.003	0.000
1.000	0.050	0.043	0.003	0.000
1.056	0.051	0.046	0.003	0.000
1.111	0.052	0.049	0.003	0.000
1.167	0.053	0.052	0.003	0.000
1.222	0.054	0.055	0.003	0.000
1.278	0.054	0.058	0.003	0.000
1.333	0.055	0.061	0.003	0.000
1.389	0.056	0.064	0.004	0.000
1.444	0.057	0.067	0.004	0.000
1.500	0.058	0.071	0.004	0.000
1.556	0.059	0.074	0.004	0.000
1.611	0.060	0.077	0.004	0.000
1.667	0.060	0.080	0.004	0.000
1.722	0.061	0.084	0.004	0.000
1.778	0.062	0.087	0.004	0.000
1.833	0.063	0.091	0.004	0.000
1.889	0.064	0.094	0.004	0.000
1.944	0.065	0.098	0.004	0.000
2.000	0.066	0.101	0.004	0.000
2.056	0.067	0.105	0.004	0.000
2.111	0.067	0.109	0.004	0.000
2.167	0.068	0.113	0.004	0.000
2.222	0.069	0.116	0.004	0.000
2.278	0.070	0.120	0.005	0.000
2.333	0.071	0.124	0.005	0.000
2.389	0.072	0.128	0.005	0.000
2.444	0.073	0.132	0.005	0.000
2.500	0.074	0.136	0.005	0.000
2.556	0.075	0.140	0.005	0.000
2.611	0.076	0.145	0.005	0.000
2.667	0.077	0.149	0.005	0.000
2.722	0.078	0.153	0.005	0.000
2.778	0.079	0.157	0.005	0.000
2.833	0.080	0.162	0.005	0.000
2.889	0.081	0.166	0.005	0.000
2.944	0.082	0.171	0.005	0.000
3.000	0.082	0.175	0.005	0.000
3.056	0.083	0.180	0.005	0.000
3.111	0.084	0.185	0.005	0.000
3.167	0.085	0.189	0.006	0.000
3.222	0.086	0.194	0.006	0.000
3.278	0.087	0.199	0.007	0.000
3.333	0.088	0.204	0.009	0.000
3.389	0.090	0.209	0.010	0.000
3.444	0.091	0.214	0.011	0.000
3.500	0.092	0.219	0.013	0.000
3.556	0.093	0.224	0.014	0.000
3.611	0.094	0.229	0.016	0.000
3.667	0.095	0.234	0.018	0.000
3.722	0.096	0.240	0.019	0.000
3.778	0.097	0.245	0.021	0.000
3.833	0.098	0.250	0.023	0.000
3.889	0.099	0.256	0.025	0.000
3.944	0.100	0.261	0.027	0.000
4.000	0.101	0.267	0.028	0.000
4.056	0.102	0.273	0.220	0.000
4.111	0.103	0.278	0.570	0.000
4.167	0.104	0.284	1.023	0.000
4.222	0.105	0.290	1.559	0.000

4.278	0.106	0.296	2.167	0.000
4.333	0.108	0.302	2.840	0.000
4.389	0.109	0.308	3.572	0.000
4.444	0.110	0.314	4.357	0.000
4.500	0.111	0.320	5.194	0.000
4.556	0.112	0.326	6.078	0.000
4.611	0.113	0.332	7.008	0.000
4.667	0.114	0.339	7.981	0.000
4.722	0.115	0.345	8.995	0.000
4.778	0.117	0.351	10.05	0.000
4.833	0.118	0.358	11.14	0.000
4.889	0.119	0.365	12.27	0.000
4.944	0.120	0.371	13.44	0.000
5.000	0.121	0.378	14.64	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.011005
5 year	0.018461
10 year	0.024053
25 year	0.031755
50 year	0.037907
100 year	0.044381

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.143725
5 year	0.191858
10 year	0.22598
25 year	0.271745
50 year	0.307814
100 year	0.345618

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.006053
5 year	0.010037
10 year	0.013592
25 year	0.019362
50 year	0.024756
100 year	0.031245

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.015	0.005
1950	0.013	0.005
1951	0.027	0.023
1952	0.006	0.004
1953	0.008	0.014
1954	0.010	0.005
1955	0.009	0.004
1956	0.017	0.020
1957	0.007	0.005
1958	0.007	0.004
1959	0.010	0.005
1960	0.047	0.008
1961	0.014	0.024
1962	0.004	0.004
1963	0.032	0.005
1964	0.013	0.005
1965	0.012	0.005
1966	0.030	0.005
1967	0.015	0.005
1968	0.007	0.004
1969	0.009	0.005

1970	0.006	0.006
1971	0.010	0.005
1972	0.017	0.019
1973	0.006	0.005
1974	0.021	0.005
1975	0.012	0.006
1976	0.013	0.005
1977	0.002	0.005
1978	0.025	0.005
1979	0.014	0.004
1980	0.018	0.015
1981	0.010	0.005
1982	0.015	0.015
1983	0.008	0.005
1984	0.004	0.005
1985	0.006	0.005
1986	0.012	0.005
1987	0.028	0.028
1988	0.008	0.005
1989	0.007	0.005
1990	0.015	0.016
1991	0.013	0.005
1992	0.008	0.005
1993	0.016	0.004
1994	0.005	0.004
1995	0.004	0.005
1996	0.014	0.012

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0319	0.0236
2	0.0303	0.0233
3	0.0282	0.0196
4	0.0265	0.0192
5	0.0252	0.0161
6	0.0213	0.0154
7	0.0179	0.0153
8	0.0172	0.0144
9	0.0170	0.0121
10	0.0159	0.0076
11	0.0151	0.0061
12	0.0151	0.0056
13	0.0149	0.0055
14	0.0147	0.0052
15	0.0144	0.0052
16	0.0139	0.0052
17	0.0136	0.0052
18	0.0134	0.0052
19	0.0132	0.0052
20	0.0129	0.0052
21	0.0126	0.0052
22	0.0122	0.0052
23	0.0119	0.0052
24	0.0119	0.0052
25	0.0102	0.0052
26	0.0096	0.0051
27	0.0095	0.0051
28	0.0095	0.0050
29	0.0092	0.0050
30	0.0087	0.0050
31	0.0084	0.0049
32	0.0081	0.0048
33	0.0080	0.0048
34	0.0076	0.0047
35	0.0074	0.0047
36	0.0072	0.0046
37	0.0071	0.0046
38	0.0066	0.0046
39	0.0065	0.0045
40	0.0065	0.0045
41	0.0064	0.0044

42	0.0056	0.0044
43	0.0048	0.0044
44	0.0041	0.0041
45	0.0038	0.0041
46	0.0036	0.0040
47	0.0019	0.0037

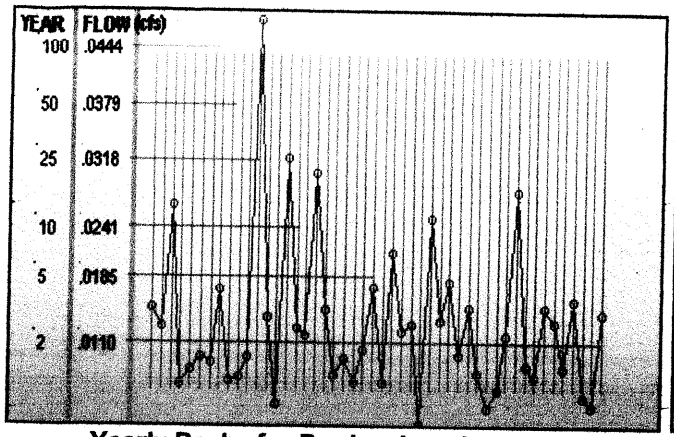
1/2 2 year to 50 year

Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0055	4173	2002	47.0	Pass
0.0058	3628	1759	48.0	Pass
0.0062	3164	1606	50.0	Pass
0.0065	2776	1493	53.0	Pass
0.0068	2463	1350	54.0	Pass
0.0071	2201	1251	56.0	Pass
0.0075	1991	1161	58.0	Pass
0.0078	1805	1082	59.0	Pass
0.0081	1618	1023	63.0	Pass
0.0084	1456	968	66.0	Pass
0.0088	1310	905	69.0	Pass
0.0091	1173	847	72.0	Pass
0.0094	1054	790	74.0	Pass
0.0098	937	723	77.0	Pass
0.0101	843	675	80.0	Pass
0.0104	746	617	82.0	Pass
0.0107	670	566	84.0	Pass
0.0111	603	514	85.0	Pass
0.0114	543	474	87.0	Pass
0.0117	480	436	90.0	Pass
0.0120	434	399	91.0	Pass
0.0124	378	370	97.0	Pass
0.0127	332	335	100.0	Pass
0.0130	293	300	102.0	Pass
0.0134	263	272	103.0	Pass
0.0137	236	242	102.0	Pass
0.0140	210	208	99.0	Pass
0.0143	184	187	101.0	Pass
0.0147	171	164	95.0	Pass
0.0150	158	148	93.0	Pass
0.0153	143	131	91.0	Pass
0.0156	129	118	91.0	Pass
0.0160	120	105	87.0	Pass
0.0163	114	98	85.0	Pass
0.0166	105	94	89.0	Pass
0.0170	95	87	91.0	Pass
0.0173	89	82	92.0	Pass
0.0176	80	78	97.0	Pass
0.0179	71	74	104.0	Pass
0.0183	65	69	106.0	Pass
0.0186	60	64	106.0	Pass
0.0189	56	58	103.0	Pass
0.0192	50	53	105.0	Pass
0.0196	47	46	97.0	Pass
0.0199	46	44	95.0	Pass
0.0202	42	40	95.0	Pass
0.0206	39	39	100.0	Pass
0.0209	36	36	100.0	Pass
0.0212	34	33	97.0	Pass
0.0215	31	29	93.0	Pass
0.0219	29	26	89.0	Pass
0.0222	26	25	96.0	Pass
0.0225	24	20	83.0	Pass
0.0229	23	19	82.0	Pass
0.0232	22	15	68.0	Pass
0.0235	18	12	66.0	Pass
0.0238	17	10	58.0	Pass
0.0242	14	9	64.0	Pass
0.0245	12	8	66.0	Pass
0.0248	10	8	80.0	Pass
0.0251	10	7	70.0	Pass
0.0255	8	7	87.0	Pass

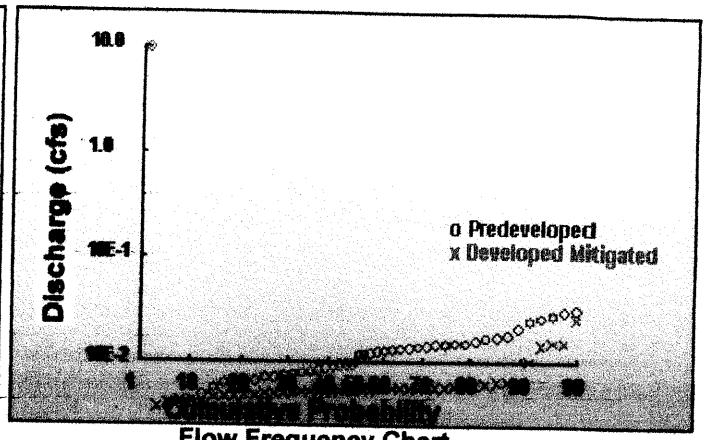
0.0258	8	6	75.0	Pass
0.0261	7	6	85.0	Pass
0.0265	7	5	71.0	Pass
0.0268	6	5	83.0	Pass
0.0271	5	3	60.0	Pass
0.0274	5	3	60.0	Pass
0.0278	5	2	40.0	Pass
0.0281	4	0	.0	Pass
0.0284	3	0	.0	Pass
0.0287	3	0	.0	Pass
0.0291	3	0	.0	Pass
0.0294	3	0	.0	Pass
0.0297	3	0	.0	Pass
0.0301	3	0	.0	Pass
0.0304	2	0	.0	Pass
0.0307	2	0	.0	Pass
0.0310	2	0	.0	Pass
0.0314	2	0	.0	Pass
0.0317	2	0	.0	Pass
0.0320	1	0	.0	Pass
0.0323	1	0	.0	Pass
0.0327	1	0	.0	Pass
0.0330	1	0	.0	Pass
0.0333	1	0	.0	Pass
0.0337	1	0	.0	Pass
0.0340	1	0	.0	Pass
0.0343	1	0	.0	Pass
0.0346	1	0	.0	Pass
0.0350	1	0	.0	Pass
0.0353	1	0	.0	Pass
0.0356	1	0	.0	Pass
0.0359	1	0	.0	Pass
0.0363	1	0	.0	Pass
0.0366	1	0	.0	Pass
0.0369	1	0	.0	Pass
0.0373	1	0	.0	Pass
0.0376	1	0	.0	Pass
0.0379	1	0	.0	Pass

Water Quality BMP Flow and Volume.
On-line facility volume: 0.054 acre-feet
On-line facility target flow: 0.06 **cfs.**
Adjusted for 15 min: 0.07 **cfs.**
Off-line facility target flow: 0.03 **cfs.**
Adjusted for 15 min: 0.04 **cfs.**

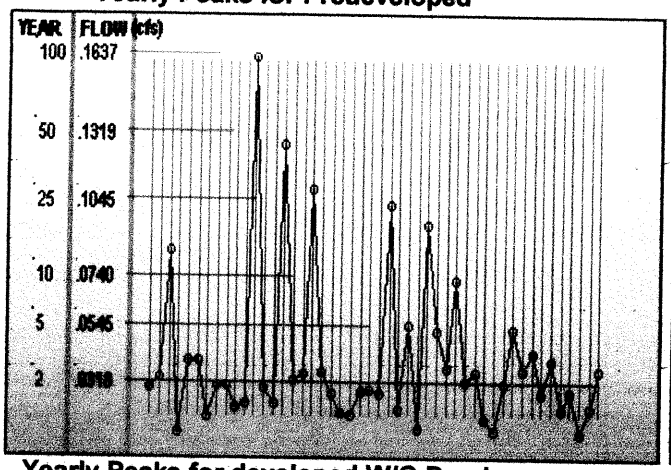
2352 CF / 21780 = 0.108 CF/SF → 0.004 CY/SF



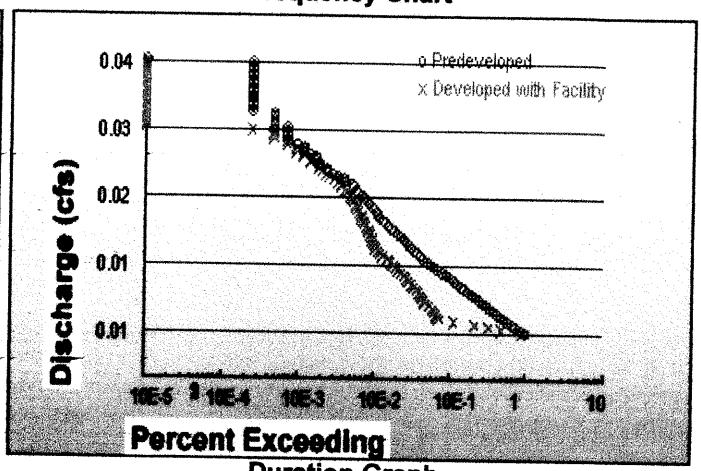
Yearly Peaks for Predeveloped



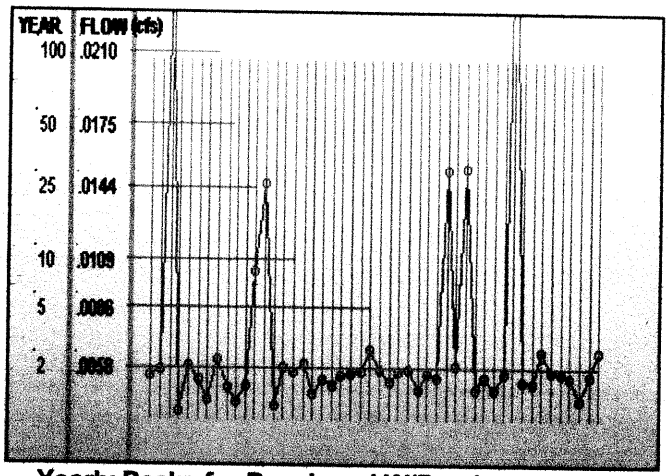
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: perv_grass
Site Address:
City :
Report Date : 7/28/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Basin 1
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.5

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
TILL GRASS:	0.5

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 4ft.
Bottom Length: 44.7ft.
Bottom Width : 14.89ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.090 acre-ft. 3920 CF / 21780 = 0.18 CF/SF → 0.007 CF/SF
Discharge Structure
Riser Height: 3 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.000 ft.
Notch Height: 0.000 ft.
Orifice 1 Diameter: 0.39 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.015	0.000	0.000	0.000
0.044	0.016	0.001	0.001	0.000
0.089	0.016	0.001	0.001	0.000
0.133	0.016	0.002	0.001	0.000
0.178	0.017	0.003	0.002	0.000

0.222	0.017	0.004	0.002	0.000
0.267	0.018	0.004	0.002	0.000
0.311	0.018	0.005	0.002	0.000
0.356	0.018	0.006	0.002	0.000
0.400	0.019	0.007	0.003	0.000
0.444	0.019	0.008	0.003	0.000
0.489	0.019	0.008	0.003	0.000
0.533	0.020	0.009	0.003	0.000
0.578	0.020	0.010	0.003	0.000
0.622	0.021	0.011	0.003	0.000
0.667	0.021	0.012	0.003	0.000
0.711	0.022	0.013	0.003	0.000
0.756	0.022	0.014	0.003	0.000
0.800	0.022	0.015	0.004	0.000
0.844	0.023	0.016	0.004	0.000
0.889	0.023	0.017	0.004	0.000
0.933	0.024	0.018	0.004	0.000
0.978	0.024	0.019	0.004	0.000
1.022	0.025	0.020	0.004	0.000
1.067	0.025	0.021	0.004	0.000
1.111	0.025	0.022	0.004	0.000
1.156	0.026	0.024	0.004	0.000
1.200	0.026	0.025	0.004	0.000
1.244	0.027	0.026	0.004	0.000
1.289	0.027	0.027	0.005	0.000
1.333	0.028	0.028	0.005	0.000
1.378	0.028	0.030	0.005	0.000
1.422	0.029	0.031	0.005	0.000
1.467	0.029	0.032	0.005	0.000
1.511	0.030	0.033	0.005	0.000
1.556	0.030	0.035	0.005	0.000
1.600	0.031	0.036	0.005	0.000
1.644	0.031	0.037	0.005	0.000
1.689	0.031	0.039	0.005	0.000
1.733	0.032	0.040	0.005	0.000
1.778	0.032	0.042	0.005	0.000
1.822	0.033	0.043	0.005	0.000
1.867	0.033	0.045	0.005	0.000
1.911	0.034	0.046	0.006	0.000
1.956	0.034	0.048	0.006	0.000
2.000	0.035	0.049	0.006	0.000
2.044	0.036	0.051	0.006	0.000
2.089	0.036	0.052	0.006	0.000
2.133	0.037	0.054	0.006	0.000
2.178	0.037	0.056	0.006	0.000
2.222	0.038	0.057	0.006	0.000
2.267	0.038	0.059	0.006	0.000
2.311	0.039	0.061	0.006	0.000
2.356	0.039	0.062	0.006	0.000
2.400	0.040	0.064	0.006	0.000
2.444	0.040	0.066	0.006	0.000
2.489	0.041	0.068	0.006	0.000
2.533	0.041	0.070	0.006	0.000
2.578	0.042	0.071	0.006	0.000
2.622	0.042	0.073	0.006	0.000
2.667	0.043	0.075	0.007	0.000
2.711	0.044	0.077	0.007	0.000
2.756	0.044	0.079	0.007	0.000
2.800	0.045	0.081	0.007	0.000
2.844	0.045	0.083	0.007	0.000
2.889	0.046	0.085	0.007	0.000
2.933	0.046	0.087	0.007	0.000
2.978	0.047	0.089	0.007	0.000
3.022	0.048	0.091	0.055	0.000
3.067	0.048	0.093	0.258	0.000
3.111	0.049	0.096	0.548	0.000
3.156	0.049	0.098	0.903	0.000
3.200	0.050	0.100	1.314	0.000
3.244	0.051	0.102	1.773	0.000
3.289	0.051	0.104	2.276	0.000
3.333	0.052	0.107	2.819	0.000
3.378	0.052	0.109	3.399	0.000

3.422	0.053	0.111	4.015	0.000
3.467	0.054	0.114	4.665	0.000
3.511	0.054	0.116	5.345	0.000
3.556	0.055	0.119	6.057	0.000
3.600	0.056	0.121	6.797	0.000
3.644	0.056	0.124	7.565	0.000
3.689	0.057	0.126	8.360	0.000
3.733	0.057	0.129	9.182	0.000
3.778	0.058	0.131	10.03	0.000
3.822	0.059	0.134	10.90	0.000
3.867	0.059	0.136	11.79	0.000
3.911	0.060	0.139	12.71	0.000
3.956	0.061	0.142	13.65	0.000
4.000	0.061	0.144	14.62	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.011005
5 year	0.018461
10 year	0.024053
25 year	0.031755
50 year	0.037907
100 year	0.044381

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.031765
5 year	0.054502
10 year	0.074008
25 year	0.104465
50 year	0.131866
100 year	0.16374

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.005798
5 year	0.008617
10 year	0.010927
25 year	0.014417
50 year	0.017477
100 year	0.020973

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.015	0.005
1950	0.013	0.006
1951	0.027	0.026
1952	0.006	0.004
1953	0.008	0.006
1954	0.010	0.005
1955	0.009	0.004
1956	0.017	0.006
1957	0.007	0.005
1958	0.007	0.004
1959	0.010	0.005
1960	0.047	0.010
1961	0.014	0.015
1962	0.004	0.004
1963	0.032	0.006
1964	0.013	0.006
1965	0.012	0.006
1966	0.030	0.005
1967	0.015	0.005
1968	0.007	0.005
1969	0.009	0.005

1970	0.006	0.006
1971	0.010	0.006
1972	0.017	0.007
1973	0.006	0.006
1974	0.021	0.005
1975	0.012	0.006
1976	0.013	0.006
1977	0.002	0.005
1978	0.025	0.006
1979	0.014	0.005
1980	0.018	0.015
1981	0.010	0.006
1982	0.015	0.015
1983	0.008	0.005
1984	0.004	0.005
1985	0.006	0.005
1986	0.012	0.005
1987	0.028	0.030
1988	0.008	0.005
1989	0.007	0.005
1990	0.015	0.007
1991	0.013	0.006
1992	0.008	0.006
1993	0.016	0.005
1994	0.005	0.004
1995	0.004	0.005
1996	0.014	0.007

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0319	0.0258
2	0.0303	0.0154
3	0.0282	0.0153
4	0.0265	0.0146
5	0.0252	0.0104
6	0.0213	0.0067
7	0.0179	0.0066
8	0.0172	0.0065
9	0.0170	0.0062
10	0.0159	0.0059
11	0.0151	0.0059
12	0.0151	0.0059
13	0.0149	0.0058
14	0.0147	0.0057
15	0.0144	0.0057
16	0.0139	0.0057
17	0.0136	0.0056
18	0.0134	0.0056
19	0.0132	0.0056
20	0.0129	0.0056
21	0.0126	0.0055
22	0.0122	0.0055
23	0.0119	0.0055
24	0.0119	0.0055
25	0.0102	0.0054
26	0.0096	0.0054
27	0.0095	0.0054
28	0.0095	0.0053
29	0.0092	0.0053
30	0.0087	0.0053
31	0.0084	0.0052
32	0.0081	0.0052
33	0.0080	0.0051
34	0.0076	0.0051
35	0.0074	0.0051
36	0.0072	0.0049
37	0.0071	0.0049
38	0.0066	0.0048
39	0.0065	0.0048
40	0.0065	0.0047
41	0.0064	0.0047

42	0.0056	0.0046
43	0.0048	0.0042
44	0.0041	0.0042
45	0.0038	0.0042
46	0.0036	0.0040
47	0.0019	0.0037

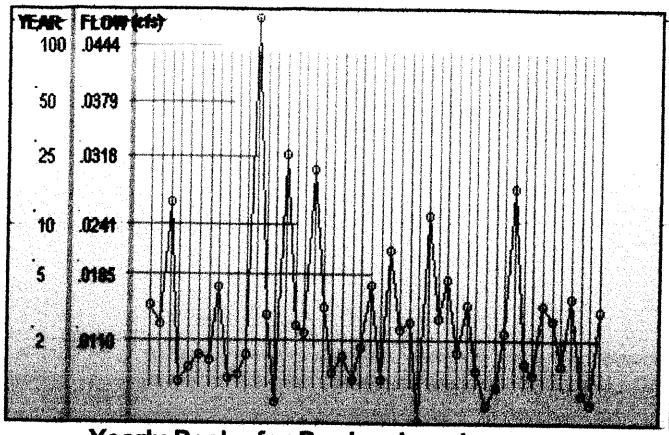
1/2 2 year to 50 year

Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0055	4173	3946	94.0	Pass
0.0058	3628	2059	56.0	Pass
0.0062	3164	1386	43.0	Pass
0.0065	2776	923	33.0	Pass
0.0068	2463	482	19.0	Pass
0.0071	2201	306	13.0	Pass
0.0075	1991	290	14.0	Pass
0.0078	1805	282	15.0	Pass
0.0081	1618	266	16.0	Pass
0.0084	1456	251	17.0	Pass
0.0088	1310	226	17.0	Pass
0.0091	1173	202	17.0	Pass
0.0094	1054	194	18.0	Pass
0.0098	937	185	19.0	Pass
0.0101	843	175	20.0	Pass
0.0104	746	165	22.0	Pass
0.0107	670	155	23.0	Pass
0.0111	603	143	23.0	Pass
0.0114	543	133	24.0	Pass
0.0117	480	122	25.0	Pass
0.0120	434	116	26.0	Pass
0.0124	378	107	28.0	Pass
0.0127	332	98	29.0	Pass
0.0130	293	88	30.0	Pass
0.0134	263	83	31.0	Pass
0.0137	236	77	32.0	Pass
0.0140	210	71	33.0	Pass
0.0143	184	65	35.0	Pass
0.0147	171	56	32.0	Pass
0.0150	158	51	32.0	Pass
0.0153	143	48	33.0	Pass
0.0156	129	45	34.0	Pass
0.0160	120	44	36.0	Pass
0.0163	114	42	36.0	Pass
0.0166	105	40	38.0	Pass
0.0170	95	40	42.0	Pass
0.0173	89	38	42.0	Pass
0.0176	80	36	45.0	Pass
0.0179	71	36	50.0	Pass
0.0183	65	34	52.0	Pass
0.0186	60	32	53.0	Pass
0.0189	56	31	55.0	Pass
0.0192	50	29	58.0	Pass
0.0196	47	29	61.0	Pass
0.0199	46	27	58.0	Pass
0.0202	42	26	61.0	Pass
0.0206	39	25	64.0	Pass
0.0209	36	24	66.0	Pass
0.0212	34	23	67.0	Pass
0.0215	31	22	70.0	Pass
0.0219	29	21	72.0	Pass
0.0222	26	19	73.0	Pass
0.0225	24	18	75.0	Pass
0.0229	23	16	69.0	Pass
0.0232	22	16	72.0	Pass
0.0235	18	14	77.0	Pass
0.0238	17	13	76.0	Pass
0.0242	14	11	78.0	Pass
0.0245	12	10	83.0	Pass
0.0248	10	9	90.0	Pass
0.0251	10	8	80.0	Pass
0.0255	8	8	100.0	Pass

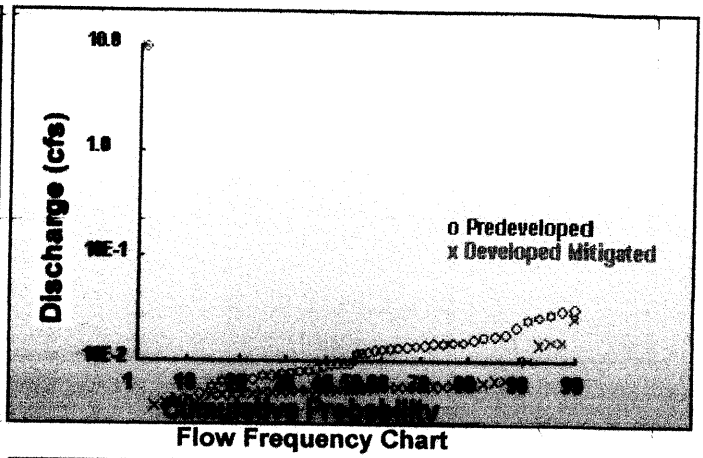
0.0258	8	6	75.0	Pass
0.0261	7	6	85.0	Pass
0.0265	7	5	71.0	Pass
0.0268	6	5	83.0	Pass
0.0271	5	4	80.0	Pass
0.0274	5	4	80.0	Pass
0.0278	5	4	80.0	Pass
0.0281	4	3	75.0	Pass
0.0284	3	3	100.0	Pass
0.0287	3	2	66.0	Pass
0.0291	3	2	66.0	Pass
0.0294	3	2	66.0	Pass
0.0297	3	1	33.0	Pass
0.0301	3	0	.0	Pass
0.0304	2	0	.0	Pass
0.0307	2	0	.0	Pass
0.0310	2	0	.0	Pass
0.0314	2	0	.0	Pass
0.0317	2	0	.0	Pass
0.0320	1	0	.0	Pass
0.0323	1	0	.0	Pass
0.0327	1	0	.0	Pass
0.0330	1	0	.0	Pass
0.0333	1	0	.0	Pass
0.0337	1	0	.0	Pass
0.0340	1	0	.0	Pass
0.0343	1	0	.0	Pass
0.0346	1	0	.0	Pass
0.0350	1	0	.0	Pass
0.0353	1	0	.0	Pass
0.0356	1	0	.0	Pass
0.0359	1	0	.0	Pass
0.0363	1	0	.0	Pass
0.0366	1	0	.0	Pass
0.0369	1	0	.0	Pass
0.0373	1	0	.0	Pass
0.0376	1	0	.0	Pass
0.0379	1	0	.0	Pass

Water Quality BMP Flow and Volume.
On-line facility volume: 0.023 acre-feet
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 0.01 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

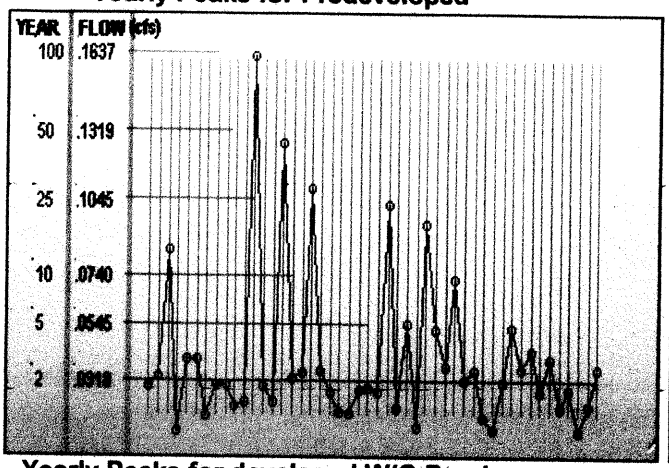
1002 CF / 21780 SF = 0.046 CF/SF → 0.002 cy/SF



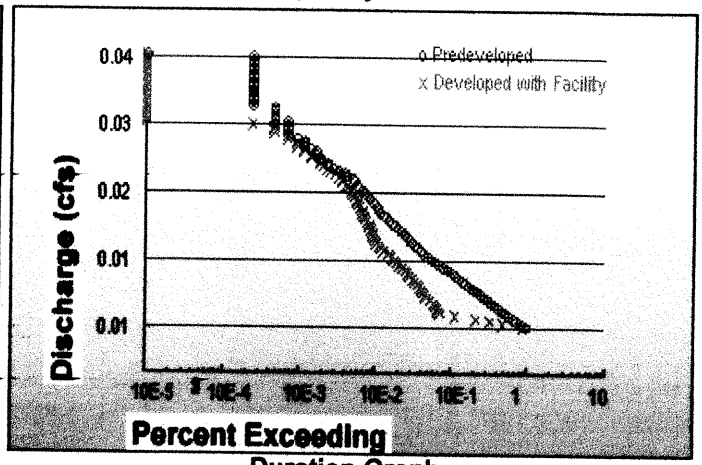
Yearly Peaks for Predeveloped



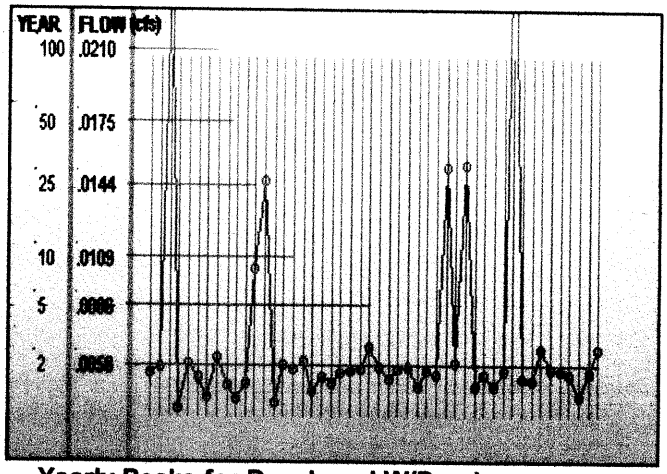
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX D

WWHM Output for Parking Lot Designs

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: Parking(open pond)
Site Address:
City :
Report Date : 7/27/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.519

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.519

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 71.02ft.
Bottom Width : 23.68ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.276 acre-ft. 12023 CF → 445 CY
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 0.851 ft.
Orifice 1 Diameter: 0.344 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.039	0.000	0.000	0.000
0.056	0.039	0.002	0.001	0.000
0.111	0.040	0.004	0.001	0.000
0.167	0.041	0.007	0.001	0.000
0.222	0.042	0.009	0.001	0.000

0.278	0.042	0.011	0.002	0.000
0.333	0.043	0.014	0.002	0.000
0.389	0.044	0.016	0.002	0.000
0.444	0.045	0.018	0.002	0.000
0.500	0.045	0.021	0.002	0.000
0.556	0.046	0.024	0.002	0.000
0.611	0.047	0.026	0.002	0.000
0.667	0.048	0.029	0.003	0.000
0.722	0.048	0.031	0.003	0.000
0.778	0.049	0.034	0.003	0.000
0.833	0.050	0.037	0.003	0.000
0.889	0.051	0.040	0.003	0.000
0.944	0.052	0.043	0.003	0.000
1.000	0.052	0.045	0.003	0.000
1.056	0.053	0.048	0.003	0.000
1.111	0.054	0.051	0.003	0.000
1.167	0.055	0.054	0.003	0.000
1.222	0.056	0.057	0.003	0.000
1.278	0.057	0.061	0.004	0.000
1.333	0.057	0.064	0.004	0.000
1.389	0.058	0.067	0.004	0.000
1.444	0.059	0.070	0.004	0.000
1.500	0.060	0.074	0.004	0.000
1.556	0.061	0.077	0.004	0.000
1.611	0.062	0.080	0.004	0.000
1.667	0.063	0.084	0.004	0.000
1.722	0.064	0.087	0.004	0.000
1.778	0.064	0.091	0.004	0.000
1.833	0.065	0.094	0.004	0.000
1.889	0.066	0.098	0.004	0.000
1.944	0.067	0.102	0.004	0.000
2.000	0.068	0.106	0.004	0.000
2.056	0.069	0.109	0.004	0.000
2.111	0.070	0.113	0.005	0.000
2.167	0.071	0.117	0.005	0.000
2.222	0.072	0.121	0.005	0.000
2.278	0.073	0.125	0.005	0.000
2.333	0.074	0.129	0.005	0.000
2.389	0.074	0.133	0.005	0.000
2.444	0.075	0.137	0.005	0.000
2.500	0.076	0.142	0.005	0.000
2.556	0.077	0.146	0.005	0.000
2.611	0.078	0.150	0.005	0.000
2.667	0.079	0.155	0.005	0.000
2.722	0.080	0.159	0.005	0.000
2.778	0.081	0.163	0.005	0.000
2.833	0.082	0.168	0.005	0.000
2.889	0.083	0.173	0.005	0.000
2.944	0.084	0.177	0.005	0.000
3.000	0.085	0.182	0.005	0.000
3.056	0.086	0.187	0.005	0.000
3.111	0.087	0.192	0.005	0.000
3.167	0.088	0.196	0.006	0.000
3.222	0.089	0.201	0.006	0.000
3.278	0.090	0.206	0.007	0.000
3.333	0.091	0.211	0.008	0.000
3.389	0.092	0.216	0.009	0.000
3.444	0.093	0.222	0.011	0.000
3.500	0.094	0.227	0.012	0.000
3.556	0.095	0.232	0.014	0.000
3.611	0.096	0.237	0.015	0.000
3.667	0.098	0.243	0.017	0.000
3.722	0.099	0.248	0.019	0.000
3.778	0.100	0.254	0.021	0.000
3.833	0.101	0.259	0.022	0.000
3.889	0.102	0.265	0.024	0.000
3.944	0.103	0.271	0.026	0.000
4.000	0.104	0.276	0.028	0.000
4.056	0.105	0.282	0.219	0.000
4.111	0.106	0.288	0.569	0.000
4.167	0.107	0.294	1.022	0.000
4.222	0.108	0.300	1.558	0.000

4.278	0.110	0.306	2.167	0.000
4.333	0.111	0.312	2.840	0.000
4.389	0.112	0.318	3.571	0.000
4.444	0.113	0.325	4.357	0.000
4.500	0.114	0.331	5.193	0.000
4.556	0.115	0.337	6.078	0.000
4.611	0.116	0.344	7.007	0.000
4.667	0.117	0.350	7.980	0.000
4.722	0.119	0.357	8.995	0.000
4.778	0.120	0.363	10.05	0.000
4.833	0.121	0.370	11.14	0.000
4.889	0.122	0.377	12.27	0.000
4.944	0.123	0.384	13.44	0.000
5.000	0.124	0.391	14.64	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.011445
5 year	0.0192
10 year	0.025015
25 year	0.033025
50 year	0.039423
100 year	0.046157

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.149474
5 year	0.199532
10 year	0.235019
25 year	0.282615
50 year	0.320127
100 year	0.359442

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.006273
5 year	0.010398
10 year	0.014078
25 year	0.02005
50 year	0.025631
100 year	0.032345

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.016	0.005
1950	0.013	0.005
1951	0.028	0.024
1952	0.007	0.004
1953	0.008	0.015
1954	0.010	0.005
1955	0.009	0.004
1956	0.018	0.019
1957	0.007	0.005
1958	0.007	0.005
1959	0.010	0.005
1960	0.049	0.008
1961	0.014	0.024
1962	0.004	0.004
1963	0.033	0.005
1964	0.013	0.005
1965	0.012	0.005
1966	0.032	0.005
1967	0.015	0.005
1968	0.008	0.005
1969	0.010	0.005

1970	0.007	0.006
1971	0.011	0.005
1972	0.018	0.019
1973	0.007	0.005
1974	0.022	0.005
1975	0.013	0.006
1976	0.014	0.006
1977	0.002	0.005
1978	0.026	0.005
1979	0.014	0.005
1980	0.019	0.016
1981	0.010	0.005
1982	0.016	0.016
1983	0.008	0.005
1984	0.004	0.005
1985	0.006	0.005
1986	0.012	0.005
1987	0.029	0.034
1988	0.009	0.005
1989	0.007	0.005
1990	0.016	0.016
1991	0.014	0.005
1992	0.008	0.005
1993	0.017	0.005
1994	0.005	0.004
1995	0.004	0.005
1996	0.015	0.012

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0332	0.0240
2	0.0315	0.0237
3	0.0293	0.0194
4	0.0276	0.0192
5	0.0262	0.0164
6	0.0221	0.0155
7	0.0187	0.0155
8	0.0179	0.0148
9	0.0177	0.0121
10	0.0165	0.0076
11	0.0157	0.0060
12	0.0157	0.0057
13	0.0155	0.0056
14	0.0153	0.0055
15	0.0149	0.0055
16	0.0145	0.0055
17	0.0141	0.0054
18	0.0140	0.0054
19	0.0137	0.0054
20	0.0135	0.0054
21	0.0132	0.0054
22	0.0127	0.0054
23	0.0124	0.0054
24	0.0124	0.0054
25	0.0106	0.0054
26	0.0100	0.0054
27	0.0099	0.0054
28	0.0099	0.0053
29	0.0096	0.0052
30	0.0091	0.0052
31	0.0087	0.0051
32	0.0084	0.0050
33	0.0083	0.0050
34	0.0079	0.0049
35	0.0077	0.0049
36	0.0074	0.0048
37	0.0074	0.0048
38	0.0069	0.0048
39	0.0067	0.0047
40	0.0067	0.0047
41	0.0067	0.0046

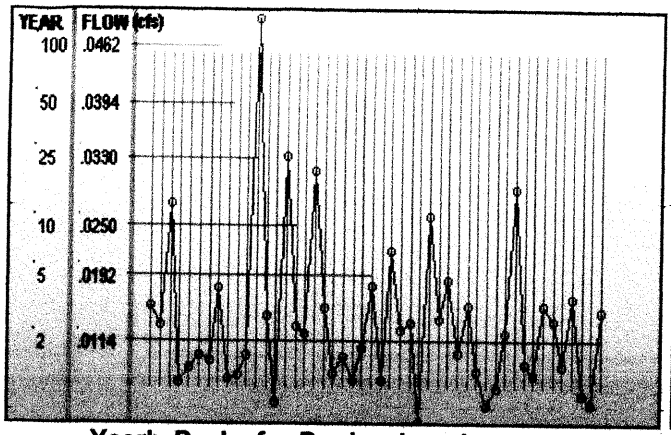
42	0.0059	0.0045
43	0.0050	0.0045
44	0.0043	0.0043
45	0.0040	0.0043
46	0.0038	0.0041
47	0.0020	0.0039

1/2 2 year to 50 year

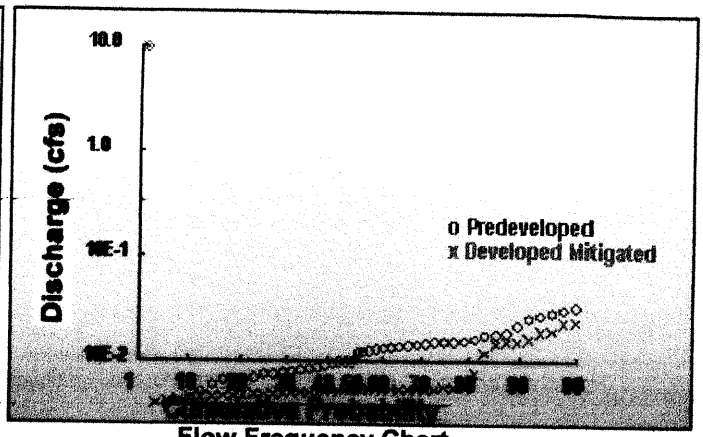
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0057	4174	1926	46.0	Pass
0.0061	3628	1740	47.0	Pass
0.0064	3165	1592	50.0	Pass
0.0067	2776	1478	53.0	Pass
0.0071	2463	1324	53.0	Pass
0.0074	2202	1227	55.0	Pass
0.0078	1991	1140	57.0	Pass
0.0081	1805	1060	58.0	Pass
0.0084	1620	1001	61.0	Pass
0.0088	1456	936	64.0	Pass
0.0091	1310	879	67.0	Pass
0.0095	1173	816	69.0	Pass
0.0098	1054	759	72.0	Pass
0.0101	938	703	74.0	Pass
0.0105	843	641	76.0	Pass
0.0108	747	592	79.0	Pass
0.0112	670	535	79.0	Pass
0.0115	603	494	81.0	Pass
0.0118	545	450	82.0	Pass
0.0122	480	405	84.0	Pass
0.0125	432	376	87.0	Pass
0.0129	378	343	90.0	Pass
0.0132	332	310	93.0	Pass
0.0136	293	276	94.0	Pass
0.0139	263	246	93.0	Pass
0.0142	236	214	90.0	Pass
0.0146	210	186	88.0	Pass
0.0149	184	163	88.0	Pass
0.0153	171	146	85.0	Pass
0.0156	158	126	79.0	Pass
0.0159	143	117	81.0	Pass
0.0163	129	105	81.0	Pass
0.0166	120	97	80.0	Pass
0.0170	114	91	79.0	Pass
0.0173	106	85	80.0	Pass
0.0176	95	82	86.0	Pass
0.0180	89	76	85.0	Pass
0.0183	80	70	87.0	Pass
0.0187	72	65	90.0	Pass
0.0190	65	60	92.0	Pass
0.0193	60	51	85.0	Pass
0.0197	56	47	83.0	Pass
0.0200	50	46	92.0	Pass
0.0204	47	43	91.0	Pass
0.0207	46	39	84.0	Pass
0.0210	42	38	90.0	Pass
0.0214	39	33	84.0	Pass
0.0217	36	30	83.0	Pass
0.0221	34	27	79.0	Pass
0.0224	31	24	77.0	Pass
0.0227	29	23	79.0	Pass
0.0231	26	19	73.0	Pass
0.0234	24	17	70.0	Pass
0.0238	23	12	52.0	Pass
0.0241	22	9	40.0	Pass
0.0244	18	8	44.0	Pass
0.0248	17	8	47.0	Pass
0.0251	14	7	50.0	Pass
0.0255	12	7	58.0	Pass
0.0258	10	6	60.0	Pass
0.0261	10	5	50.0	Pass
0.0265	8	5	62.0	Pass

0.0268	8	4	50.0	Pass
0.0272	7	4	57.0	Pass
0.0275	7	3	42.0	Pass
0.0278	6	2	33.0	Pass
0.0282	5	2	40.0	Pass
0.0285	5	2	40.0	Pass
0.0289	5	2	40.0	Pass
0.0292	4	2	50.0	Pass
0.0296	3	2	66.0	Pass
0.0299	3	2	66.0	Pass
0.0302	3	2	66.0	Pass
0.0306	3	2	66.0	Pass
0.0309	3	2	66.0	Pass
0.0313	3	2	66.0	Pass
0.0316	2	2	100.0	Pass
0.0319	2	2	100.0	Pass
0.0323	2	2	100.0	Pass
0.0326	2	2	100.0	Pass
0.0330	2	2	100.0	Pass
0.0333	1	1	100.0	Pass
0.0336	1	1	100.0	Pass
0.0340	1	1	100.0	Pass
0.0343	1	0	.0	Pass
0.0347	1	0	.0	Pass
0.0350	1	0	.0	Pass
0.0353	1	0	.0	Pass
0.0357	1	0	.0	Pass
0.0360	1	0	.0	Pass
0.0364	1	0	.0	Pass
0.0367	1	0	.0	Pass
0.0370	1	0	.0	Pass
0.0374	1	0	.0	Pass
0.0377	1	0	.0	Pass
0.0381	1	0	.0	Pass
0.0384	1	0	.0	Pass
0.0387	1	0	.0	Pass
0.0391	1	0	.0	Pass
0.0394	1	0	.0	Pass

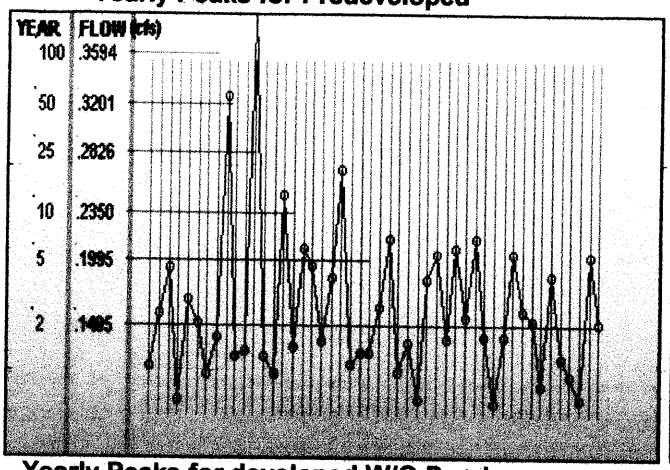
Water Quality BMP Flow and Volume.
On-line facility volume: 0.019 acre-feet 828 cf → 31 cy
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 0.01 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**



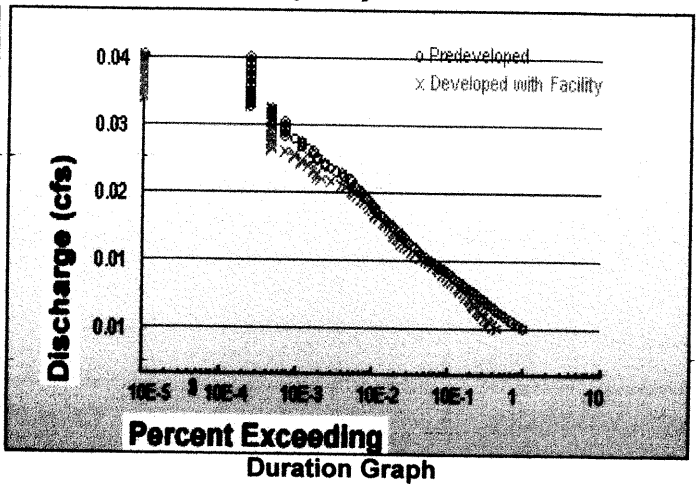
Yearly Peaks for Predeveloped



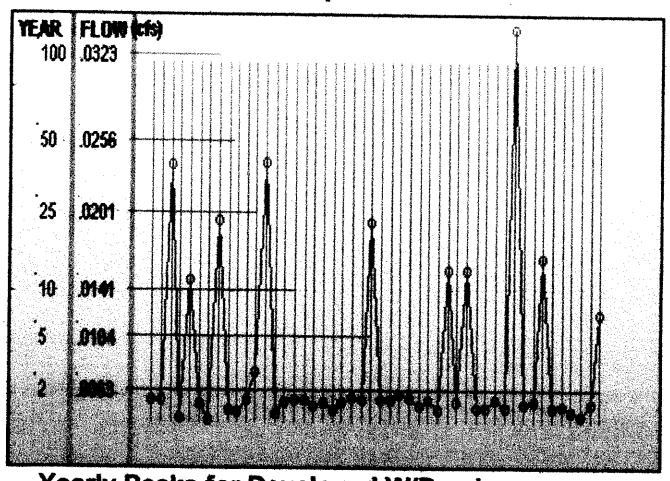
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: Parking(vault)
Site Address:
City :
Report Date : 7/27/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.459

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.459

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 65.5ft.
Bottom Width : 21.86ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.245 acre-ft. 10,672 CF
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 0.811 ft.
Orifice 1 Diameter: 0.321 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.033	0.000	0.000	0.000
0.056	0.034	0.002	0.001	0.000
0.111	0.034	0.004	0.001	0.000
0.167	0.035	0.006	0.001	0.000
0.222	0.036	0.008	0.001	0.000

0.278	0.036	0.010	0.001	0.000
0.333	0.037	0.012	0.002	0.000
0.389	0.038	0.014	0.002	0.000
0.444	0.038	0.016	0.002	0.000
0.500	0.039	0.018	0.002	0.000
0.556	0.040	0.020	0.002	0.000
0.611	0.041	0.022	0.002	0.000
0.667	0.041	0.025	0.002	0.000
0.722	0.042	0.027	0.002	0.000
0.778	0.043	0.029	0.002	0.000
0.833	0.043	0.032	0.002	0.000
0.889	0.044	0.034	0.003	0.000
0.944	0.045	0.037	0.003	0.000
1.000	0.046	0.039	0.003	0.000
1.056	0.046	0.042	0.003	0.000
1.111	0.047	0.044	0.003	0.000
1.167	0.048	0.047	0.003	0.000
1.222	0.049	0.050	0.003	0.000
1.278	0.050	0.052	0.003	0.000
1.333	0.050	0.055	0.003	0.000
1.389	0.051	0.058	0.003	0.000
1.444	0.052	0.061	0.003	0.000
1.500	0.053	0.064	0.003	0.000
1.556	0.054	0.067	0.003	0.000
1.611	0.054	0.070	0.003	0.000
1.667	0.055	0.073	0.003	0.000
1.722	0.056	0.076	0.004	0.000
1.778	0.057	0.079	0.004	0.000
1.833	0.058	0.082	0.004	0.000
1.889	0.059	0.085	0.004	0.000
1.944	0.059	0.089	0.004	0.000
2.000	0.060	0.092	0.004	0.000
2.056	0.061	0.095	0.004	0.000
2.111	0.062	0.099	0.004	0.000
2.167	0.063	0.102	0.004	0.000
2.222	0.064	0.106	0.004	0.000
2.278	0.065	0.109	0.004	0.000
2.333	0.065	0.113	0.004	0.000
2.389	0.066	0.117	0.004	0.000
2.444	0.067	0.120	0.004	0.000
2.500	0.068	0.124	0.004	0.000
2.556	0.069	0.128	0.004	0.000
2.611	0.070	0.132	0.004	0.000
2.667	0.071	0.136	0.004	0.000
2.722	0.072	0.140	0.004	0.000
2.778	0.073	0.144	0.005	0.000
2.833	0.074	0.148	0.005	0.000
2.889	0.075	0.152	0.005	0.000
2.944	0.075	0.156	0.005	0.000
3.000	0.076	0.160	0.005	0.000
3.056	0.077	0.164	0.005	0.000
3.111	0.078	0.169	0.005	0.000
3.167	0.079	0.173	0.005	0.000
3.222	0.080	0.178	0.005	0.000
3.278	0.081	0.182	0.006	0.000
3.333	0.082	0.187	0.007	0.000
3.389	0.083	0.191	0.008	0.000
3.444	0.084	0.196	0.009	0.000
3.500	0.085	0.201	0.010	0.000
3.556	0.086	0.205	0.012	0.000
3.611	0.087	0.210	0.014	0.000
3.667	0.088	0.215	0.015	0.000
3.722	0.089	0.220	0.017	0.000
3.778	0.090	0.225	0.019	0.000
3.833	0.091	0.230	0.020	0.000
3.889	0.092	0.235	0.022	0.000
3.944	0.093	0.240	0.024	0.000
4.000	0.094	0.245	0.026	0.000
4.056	0.095	0.251	0.217	0.000
4.111	0.096	0.256	0.567	0.000
4.167	0.097	0.261	1.020	0.000
4.222	0.098	0.267	1.556	0.000

4.278	0.099	0.272	2.165	0.000
4.333	0.101	0.278	2.837	0.000
4.389	0.102	0.283	3.569	0.000
4.444	0.103	0.289	4.355	0.000
4.500	0.104	0.295	5.191	0.000
4.556	0.105	0.301	6.075	0.000
4.611	0.106	0.307	7.005	0.000
4.667	0.107	0.312	7.978	0.000
4.722	0.108	0.318	8.993	0.000
4.778	0.109	0.324	10.05	0.000
4.833	0.110	0.331	11.14	0.000
4.889	0.111	0.337	12.27	0.000
4.944	0.113	0.343	13.43	0.000
5.000	0.114	0.349	14.63	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.010125
5 year	0.016984
10 year	0.022129
25 year	0.029215
50 year	0.034874
100 year	0.040831

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.132227
5 year	0.176509
10 year	0.207901
25 year	0.250005
50 year	0.283189
100 year	0.317968

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.005515
5 year	0.00923
10 year	0.012569
25 year	0.018021
50 year	0.023145
100 year	0.029337

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.014	0.005
1950	0.012	0.005
1951	0.024	0.022
1952	0.006	0.004
1953	0.007	0.013
1954	0.009	0.004
1955	0.008	0.003
1956	0.016	0.018
1957	0.006	0.004
1958	0.007	0.004
1959	0.009	0.005
1960	0.044	0.006
1961	0.013	0.022
1962	0.004	0.004
1963	0.029	0.005
1964	0.012	0.005
1965	0.011	0.005
1966	0.028	0.004
1967	0.014	0.005
1968	0.007	0.004
1969	0.008	0.005

1970	0.006	0.005
1971	0.009	0.005
1972	0.016	0.018
1973	0.006	0.005
1974	0.020	0.005
1975	0.011	0.005
1976	0.012	0.005
1977	0.002	0.004
1978	0.023	0.005
1979	0.012	0.004
1980	0.017	0.014
1981	0.009	0.005
1982	0.014	0.014
1983	0.007	0.004
1984	0.003	0.004
1985	0.005	0.005
1986	0.011	0.004
1987	0.026	0.029
1988	0.008	0.005
1989	0.007	0.005
1990	0.014	0.015
1991	0.012	0.004
1992	0.007	0.004
1993	0.015	0.004
1994	0.004	0.004
1995	0.004	0.005
1996	0.013	0.011

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0294	0.0220
2	0.0279	0.0219
3	0.0259	0.0180
4	0.0244	0.0178
5	0.0232	0.0147
6	0.0196	0.0141
7	0.0165	0.0140
8	0.0159	0.0133
9	0.0157	0.0109
10	0.0146	0.0064
11	0.0139	0.0052
12	0.0138	0.0049
13	0.0137	0.0049
14	0.0136	0.0048
15	0.0132	0.0048
16	0.0128	0.0048
17	0.0125	0.0048
18	0.0123	0.0048
19	0.0121	0.0048
20	0.0119	0.0047
21	0.0116	0.0047
22	0.0113	0.0047
23	0.0110	0.0047
24	0.0109	0.0047
25	0.0094	0.0047
26	0.0089	0.0047
27	0.0088	0.0047
28	0.0087	0.0046
29	0.0085	0.0046
30	0.0080	0.0045
31	0.0077	0.0045
32	0.0074	0.0044
33	0.0073	0.0043
34	0.0070	0.0043
35	0.0068	0.0043
36	0.0066	0.0042
37	0.0065	0.0042
38	0.0061	0.0042
39	0.0060	0.0041
40	0.0059	0.0041
41	0.0059	0.0040

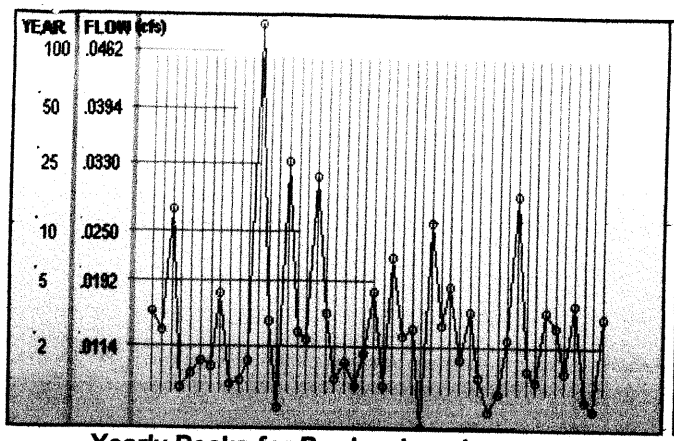
42	0.0052	0.0040
43	0.0045	0.0040
44	0.0038	0.0038
45	0.0035	0.0038
46	0.0034	0.0036
47	0.0017	0.0034

1/2 2 year to 50 year

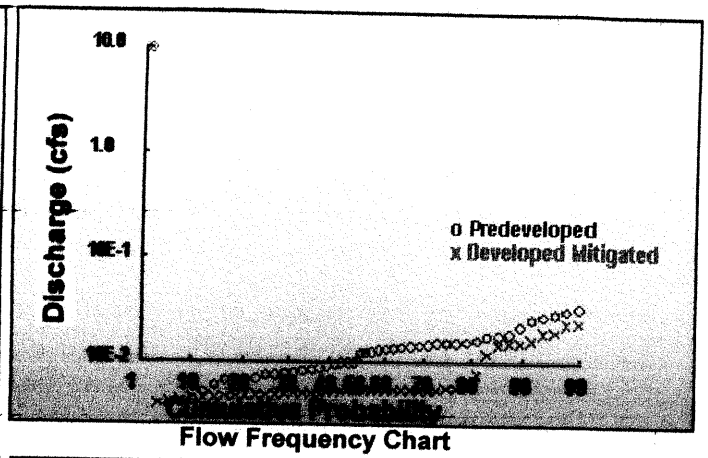
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0051	4173	1821	43.0	Pass
0.0054	3628	1679	46.0	Pass
0.0057	3165	1540	48.0	Pass
0.0060	2776	1406	50.0	Pass
0.0063	2462	1283	52.0	Pass
0.0066	2201	1189	54.0	Pass
0.0069	1991	1114	55.0	Pass
0.0072	1805	1040	57.0	Pass
0.0075	1618	980	60.0	Pass
0.0078	1456	915	62.0	Pass
0.0081	1310	866	66.0	Pass
0.0084	1173	810	69.0	Pass
0.0087	1054	751	71.0	Pass
0.0090	937	698	74.0	Pass
0.0093	841	640	76.0	Pass
0.0096	746	583	78.0	Pass
0.0099	667	541	81.0	Pass
0.0102	602	496	82.0	Pass
0.0105	543	453	83.0	Pass
0.0108	480	423	88.0	Pass
0.0111	434	382	88.0	Pass
0.0114	378	350	92.0	Pass
0.0117	332	322	96.0	Pass
0.0120	293	289	98.0	Pass
0.0123	263	259	98.0	Pass
0.0126	236	232	98.0	Pass
0.0129	209	201	96.0	Pass
0.0132	184	186	101.0	Pass
0.0135	171	160	93.0	Pass
0.0138	158	146	92.0	Pass
0.0141	143	126	88.0	Pass
0.0144	129	114	88.0	Pass
0.0147	120	102	85.0	Pass
0.0150	115	96	83.0	Pass
0.0153	105	92	87.0	Pass
0.0156	95	86	90.0	Pass
0.0159	89	80	89.0	Pass
0.0162	80	76	95.0	Pass
0.0165	72	73	101.0	Pass
0.0168	65	67	103.0	Pass
0.0171	60	63	104.0	Pass
0.0174	56	60	107.0	Pass
0.0177	50	53	105.0	Pass
0.0180	47	46	97.0	Pass
0.0183	46	44	95.0	Pass
0.0186	42	41	97.0	Pass
0.0189	39	39	100.0	Pass
0.0192	36	37	102.0	Pass
0.0195	34	34	100.0	Pass
0.0198	31	30	96.0	Pass
0.0201	29	28	96.0	Pass
0.0204	26	24	92.0	Pass
0.0207	24	24	100.0	Pass
0.0210	23	20	86.0	Pass
0.0213	22	18	81.0	Pass
0.0216	18	16	88.0	Pass
0.0219	17	10	58.0	Pass
0.0222	14	8	57.0	Pass
0.0225	12	8	66.0	Pass
0.0228	10	7	70.0	Pass
0.0231	10	7	70.0	Pass
0.0234	8	6	75.0	Pass

0.0237	8	6	75.0	Pass
0.0240	7	5	71.0	Pass
0.0243	7	5	71.0	Pass
0.0246	6	3	50.0	Pass
0.0249	5	3	60.0	Pass
0.0252	5	2	40.0	Pass
0.0255	5	2	40.0	Pass
0.0258	4	2	50.0	Pass
0.0261	3	2	66.0	Pass
0.0264	3	2	66.0	Pass
0.0267	3	2	66.0	Pass
0.0270	3	2	66.0	Pass
0.0273	3	2	66.0	Pass
0.0276	3	2	66.0	Pass
0.0279	2	2	100.0	Pass
0.0282	2	2	100.0	Pass
0.0286	2	1	50.0	Pass
0.0289	2	0	.0	Pass
0.0292	2	0	.0	Pass
0.0295	1	0	.0	Pass
0.0298	1	0	.0	Pass
0.0301	1	0	.0	Pass
0.0304	1	0	.0	Pass
0.0307	1	0	.0	Pass
0.0310	1	0	.0	Pass
0.0313	1	0	.0	Pass
0.0316	1	0	.0	Pass
0.0319	1	0	.0	Pass
0.0322	1	0	.0	Pass
0.0325	1	0	.0	Pass
0.0328	1	0	.0	Pass
0.0331	1	0	.0	Pass
0.0334	1	0	.0	Pass
0.0337	1	0	.0	Pass
0.0340	1	0	.0	Pass
0.0343	1	0	.0	Pass
0.0346	1	0	.0	Pass
0.0349	1	0	.0	Pass

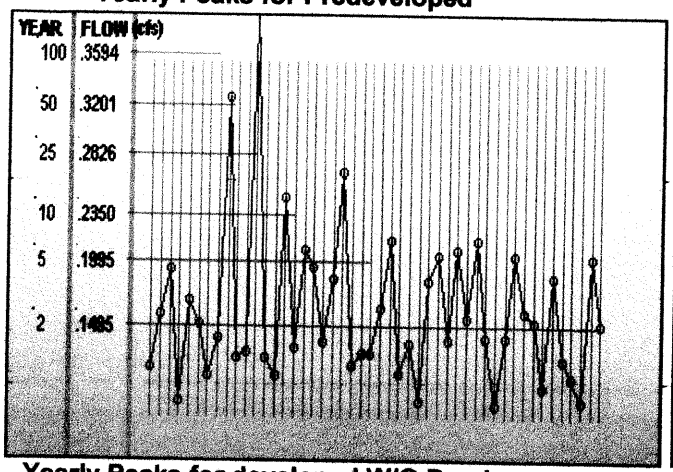
Water Quality BMP Flow and Volume.
On-line facility volume: 0.019 acre-feet → 828 cf
On-line facility target flow: 0.01 **cfs.**
Adjusted for 15 min: 0.01 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**



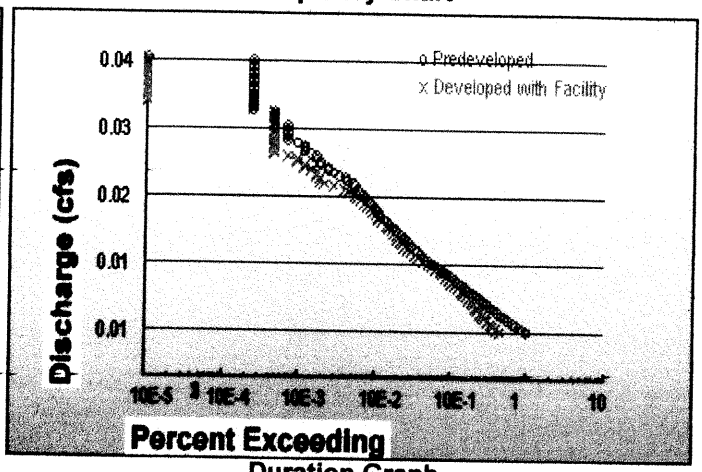
Yearly Peaks for Predeveloped



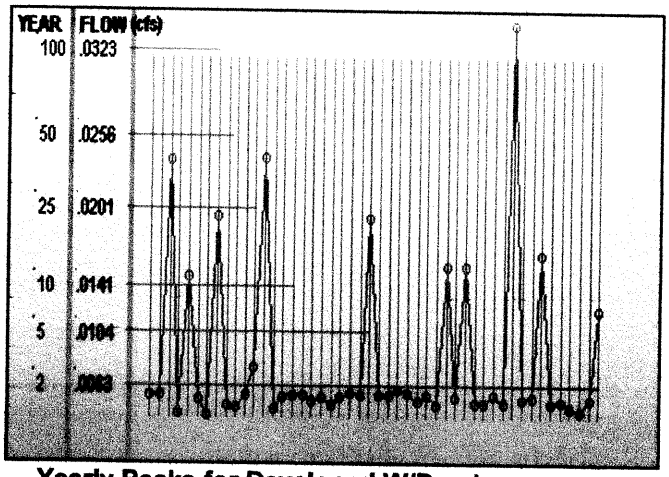
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: parking(LID_NO_INF)
Site Address:
City :
Report Date : 6/9/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.459

DEVELOPED LAND USE
Basin : Basin 1
Flows To : F_Table
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.459

RCHRES (POND) INFORMATION
Pond Name: F_Table
Pond Type: Table
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 0ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.000	0.000	0.000	0.000
0.130	0.459	0.018	0.002	0.000
0.260	0.459	0.036	0.002	0.000
0.390	0.459	0.054	0.003	0.000
0.520	0.459	0.072	0.003	0.000
0.650	0.459	0.090	0.004	0.000
0.780	0.459	0.107	0.004	0.000
0.910	0.459	0.125	0.004	0.000
1.040	0.459	0.143	0.004	0.000
1.170	0.459	0.161	0.005	0.000
1.300	0.459	0.179	0.005	0.000
1.430	0.459	0.197	0.007	0.000
1.560	0.459	0.215	0.008	0.000
1.690	0.459	0.233	0.016	0.000
1.820	0.459	0.251	0.021	0.000
1.950	0.459	0.269	0.035	0.000
2.080	0.459	0.287	0.539	0.000
2.210	0.459	0.304	1.398	0.000
2.340	0.459	0.322	2.426	0.000
2.470	0.459	0.340	2.790	0.000

2.600	0.459	0.358	3.112	0.000
2.730	0.459	0.376	3.403	0.000
2.860	0.459	0.394	3.671	0.000
2.990	0.459	0.412	3.920	0.000
3.120	0.459	0.430	4.155	0.000
3.250	0.459	0.448	4.377	0.000
3.380	0.459	0.466	4.589	0.000
3.510	0.459	0.484	4.791	0.000
3.640	0.459	0.501	4.985	0.000
3.770	0.459	0.519	5.171	0.000
3.900	0.459	0.537	5.351	0.000
4.030	0.459	0.555	5.526	0.000
4.160	0.459	0.573	5.695	0.000
4.290	0.459	0.591	5.859	0.000
4.420	0.459	0.609	6.018	0.000
4.550	0.459	0.627	6.174	0.000
4.680	0.459	0.645	6.325	0.000
4.810	0.459	0.663	6.473	0.000
4.940	0.459	0.680	6.618	0.000
5.070	0.459	0.698	6.760	0.000
5.200	0.459	0.716	6.899	0.000
5.330	0.459	0.734	7.035	0.000
5.460	0.459	0.752	7.168	0.000
5.590	0.459	0.770	7.299	0.000
5.720	0.459	0.788	7.428	0.000
5.850	0.459	0.806	7.554	0.000
5.980	0.459	0.824	7.679	0.000
6.110	0.459	0.842	7.801	0.000
6.240	0.459	0.860	7.921	0.000
6.370	0.459	0.877	8.040	0.000
6.500	0.459	0.895	8.157	0.000
6.630	0.459	0.913	8.273	0.000
6.760	0.459	0.931	8.386	0.000
6.890	0.459	0.949	8.498	0.000
7.020	0.459	0.967	8.609	0.000
7.150	0.459	0.985	8.719	0.000
7.280	0.459	1.003	8.827	0.000
7.410	0.459	1.021	8.933	0.000
7.540	0.459	1.039	9.039	0.000
7.670	0.459	1.057	9.143	0.000
7.800	0.459	1.074	9.246	0.000
7.930	0.459	1.092	9.348	0.000
8.060	0.459	1.110	9.449	0.000
8.190	0.459	1.128	9.548	0.000
8.320	0.459	1.146	9.647	0.000
8.450	0.459	1.164	9.745	0.000
8.580	0.459	1.182	9.842	0.000
8.710	0.459	1.200	9.937	0.000
8.840	0.459	1.218	10.03	0.000
8.970	0.459	1.236	10.13	0.000
9.100	0.459	1.253	10.22	0.000
9.230	0.459	1.271	10.31	0.000
9.360	0.459	1.289	10.40	0.000
9.490	0.459	1.307	10.49	0.000
9.620	0.459	1.325	10.58	0.000
9.750	0.459	1.343	10.67	0.000
9.880	0.459	1.361	10.76	0.000
10.01	0.459	1.379	10.85	0.000
10.14	0.459	1.397	10.94	0.000
10.27	0.459	1.415	11.02	0.000
10.40	0.459	1.433	11.11	0.000
10.53	0.459	1.450	11.19	0.000
10.66	0.459	1.468	11.28	0.000
10.79	0.459	1.486	11.36	0.000
10.92	0.459	1.504	11.44	0.000
11.05	0.459	1.522	11.53	0.000
11.18	0.459	1.540	11.61	0.000
11.31	0.459	1.558	11.69	0.000
11.44	0.459	1.576	11.77	0.000
11.57	0.459	1.594	11.85	0.000
11.70	0.459	1.612	11.93	0.000
11.83	0.459	1.630	12.01	0.000

11.96	0.459	1.647	12.09	0.000
12.09	0.459	1.665	12.17	0.000
12.22	0.459	1.683	12.24	0.000
12.35	0.459	1.701	12.32	0.000
12.48	0.459	1.719	12.40	0.000
12.61	0.459	1.737	12.47	0.000
12.74	0.459	1.755	12.55	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.010125
5 year	0.016984
10 year	0.022129
25 year	0.029215
50 year	0.034874
100 year	0.040831

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.132227
5 year	0.176509
10 year	0.207901
25 year	0.250005
50 year	0.283189
100 year	0.317968

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.005569
5 year	0.009136
10 year	0.012291
25 year	0.017376
50 year	0.022099
100 year	0.027753

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.014	0.005
1950	0.012	0.005
1951	0.024	0.023
1952	0.006	0.003
1953	0.007	0.014
1954	0.009	0.005
1955	0.008	0.003
1956	0.016	0.017
1957	0.006	0.004
1958	0.007	0.004
1959	0.009	0.005
1960	0.044	0.006
1961	0.013	0.022
1962	0.004	0.004
1963	0.029	0.005
1964	0.012	0.006
1965	0.011	0.005
1966	0.028	0.004
1967	0.014	0.005
1968	0.007	0.004
1969	0.008	0.005
1970	0.006	0.006
1971	0.009	0.005
1972	0.016	0.017
1973	0.006	0.005
1974	0.020	0.005
1975	0.011	0.006
1976	0.012	0.006

1977	0.002	0.004
1978	0.023	0.005
1979	0.012	0.004
1980	0.017	0.012
1981	0.009	0.005
1982	0.014	0.013
1983	0.007	0.004
1984	0.003	0.004
1985	0.005	0.005
1986	0.011	0.004
1987	0.026	0.027
1988	0.008	0.005
1989	0.007	0.005
1990	0.014	0.014
1991	0.012	0.004
1992	0.007	0.004
1993	0.015	0.004
1994	0.004	0.004
1995	0.004	0.005
1996	0.013	0.008

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

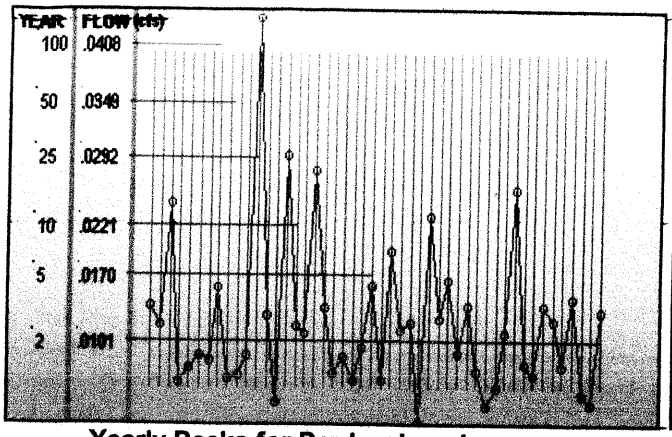
Rank	Predeveloped	Developed
1	0.0294	0.0227
2	0.0279	0.0223
3	0.0259	0.0170
4	0.0244	0.0169
5	0.0232	0.0141
6	0.0196	0.0140
7	0.0165	0.0129
8	0.0159	0.0118
9	0.0157	0.0076
10	0.0146	0.0062
11	0.0139	0.0061
12	0.0138	0.0058
13	0.0137	0.0058
14	0.0136	0.0056
15	0.0132	0.0054
16	0.0128	0.0053
17	0.0125	0.0051
18	0.0123	0.0050
19	0.0121	0.0050
20	0.0119	0.0050
21	0.0116	0.0050
22	0.0113	0.0049
23	0.0110	0.0049
24	0.0109	0.0049
25	0.0094	0.0049
26	0.0089	0.0048
27	0.0088	0.0048
28	0.0087	0.0047
29	0.0085	0.0046
30	0.0080	0.0046
31	0.0077	0.0046
32	0.0074	0.0044
33	0.0073	0.0043
34	0.0070	0.0043
35	0.0068	0.0042
36	0.0066	0.0042
37	0.0065	0.0042
38	0.0061	0.0042
39	0.0060	0.0041
40	0.0059	0.0040
41	0.0059	0.0040
42	0.0052	0.0039
43	0.0045	0.0039
44	0.0038	0.0037
45	0.0035	0.0036
46	0.0034	0.0034
47	0.0017	0.0033

1/2 2 year to 50 year

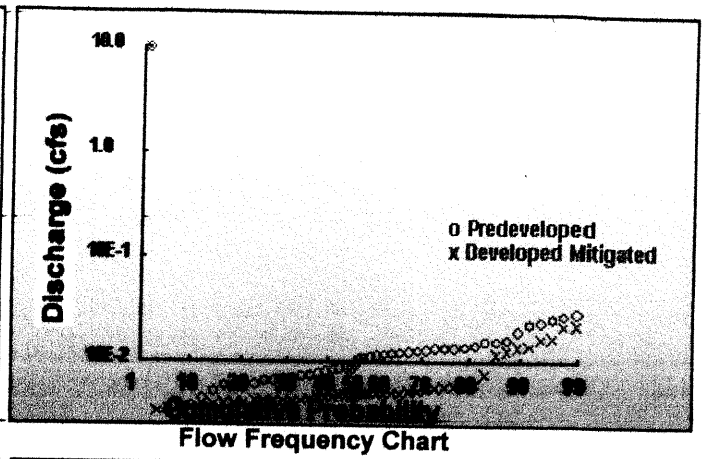
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0051	4173	2850	68.0	Pass
0.0054	3628	2465	67.0	Pass
0.0057	3165	2136	67.0	Pass
0.0060	2776	1912	68.0	Pass
0.0063	2462	1735	70.0	Pass
0.0066	2201	1533	69.0	Pass
0.0069	1991	1290	64.0	Pass
0.0072	1805	961	53.0	Pass
0.0075	1618	660	40.0	Pass
0.0078	1456	526	36.0	Pass
0.0081	1310	502	38.0	Pass
0.0084	1173	476	40.0	Pass
0.0087	1054	455	43.0	Pass
0.0090	937	427	45.0	Pass
0.0093	841	396	47.0	Pass
0.0096	746	367	49.0	Pass
0.0099	667	344	51.0	Pass
0.0102	602	317	52.0	Pass
0.0105	543	298	54.0	Pass
0.0108	480	282	58.0	Pass
0.0111	434	264	60.0	Pass
0.0114	378	246	65.0	Pass
0.0117	332	220	66.0	Pass
0.0120	293	195	66.0	Pass
0.0123	263	179	68.0	Pass
0.0126	236	165	69.0	Pass
0.0129	209	150	71.0	Pass
0.0132	184	141	76.0	Pass
0.0135	171	122	71.0	Pass
0.0138	158	116	73.0	Pass
0.0141	143	104	72.0	Pass
0.0144	129	97	75.0	Pass
0.0147	120	92	76.0	Pass
0.0150	115	89	77.0	Pass
0.0153	105	86	81.0	Pass
0.0156	95	82	86.0	Pass
0.0159	89	80	89.0	Pass
0.0162	80	74	92.0	Pass
0.0165	72	68	94.0	Pass
0.0168	65	62	95.0	Pass
0.0171	60	54	90.0	Pass
0.0174	56	52	92.0	Pass
0.0177	50	50	100.0	Pass
0.0180	47	47	100.0	Pass
0.0183	46	43	93.0	Pass
0.0186	42	42	100.0	Pass
0.0189	39	38	97.0	Pass
0.0192	36	35	97.0	Pass
0.0195	34	33	97.0	Pass
0.0198	31	29	93.0	Pass
0.0201	29	25	86.0	Pass
0.0204	26	23	88.0	Pass
0.0207	24	20	83.0	Pass
0.0210	23	17	73.0	Pass
0.0213	22	14	63.0	Pass
0.0216	18	13	72.0	Pass
0.0219	17	10	58.0	Pass
0.0222	14	8	57.0	Pass
0.0225	12	7	58.0	Pass
0.0228	10	6	60.0	Pass
0.0231	10	6	60.0	Pass
0.0234	8	5	62.0	Pass
0.0237	8	5	62.0	Pass
0.0240	7	5	71.0	Pass
0.0243	7	4	57.0	Pass
0.0246	6	3	50.0	Pass
0.0249	5	3	60.0	Pass
0.0252	5	3	60.0	Pass
0.0255	5	3	60.0	Pass

0.0258	4	2	50.0	Pass
0.0261	3	2	66.0	Pass
0.0264	3	2	66.0	Pass
0.0267	3	1	33.0	Pass
0.0270	3	0	.0	Pass
0.0273	3	0	.0	Pass
0.0276	3	0	.0	Pass
0.0279	2	0	.0	Pass
0.0282	2	0	.0	Pass
0.0286	2	0	.0	Pass
0.0289	2	0	.0	Pass
0.0292	2	0	.0	Pass
0.0295	1	0	.0	Pass
0.0298	1	0	.0	Pass
0.0301	1	0	.0	Pass
0.0304	1	0	.0	Pass
0.0307	1	0	.0	Pass
0.0310	1	0	.0	Pass
0.0313	1	0	.0	Pass
0.0316	1	0	.0	Pass
0.0319	1	0	.0	Pass
0.0322	1	0	.0	Pass
0.0325	1	0	.0	Pass
0.0328	1	0	.0	Pass
0.0331	1	0	.0	Pass
0.0334	1	0	.0	Pass
0.0337	1	0	.0	Pass
0.0340	1	0	.0	Pass
0.0343	1	0	.0	Pass
0.0346	1	0	.0	Pass
0.0349	1	0	.0	Pass

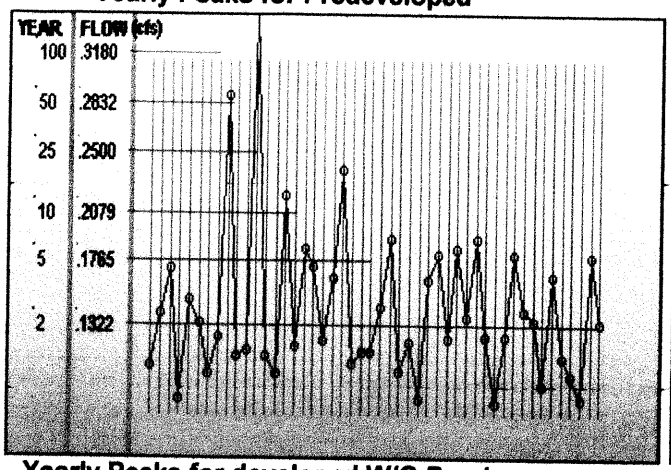
Water Quality BMP Flow and Volume.
On-line facility volume: 0.008 acre-feet
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**



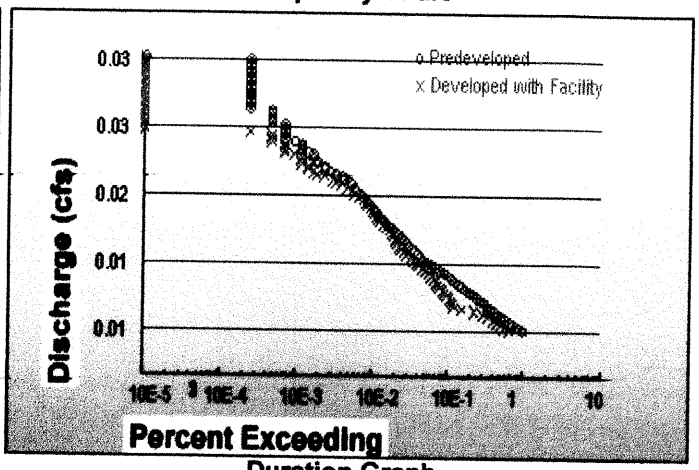
Yearly Peaks for Predeveloped



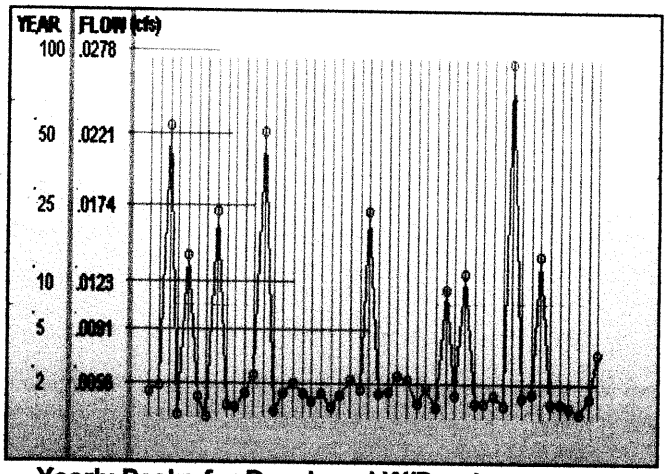
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX E

WWHM Output for Soil Rehabilitation

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: landscape
Site Address:
City :
Report Date : 6/10/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00
Pan Evap Factor entered by user: 0

PREDEVELOPED LAND USE

Basin : Basin 1
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.574

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
TILL GRASS:	0.574

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 11.42ft.
Bottom Width : 3.87ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.039 acre-ft. - 1699 CF
169.9 CF / 2500 SF landscape
6.29 cy.
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.011 ft.
Notch Height: 1.480 ft.
Orifice 1 Diameter: 0.643 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.001	0.000	0.000	0.000
0.056	0.001	0.000	0.003	0.000
0.111	0.001	0.000	0.004	0.000
0.167	0.001	0.000	0.004	0.000

0.222	0.002	0.000	0.005	0.000
0.278	0.002	0.000	0.006	0.000
0.333	0.002	0.000	0.006	0.000
0.389	0.002	0.001	0.007	0.000
0.444	0.002	0.001	0.007	0.000
0.500	0.002	0.001	0.008	0.000
0.556	0.002	0.001	0.008	0.000
0.611	0.003	0.001	0.008	0.000
0.667	0.003	0.001	0.009	0.000
0.722	0.003	0.001	0.009	0.000
0.778	0.003	0.002	0.010	0.000
0.833	0.003	0.002	0.010	0.000
0.889	0.004	0.002	0.010	0.000
0.944	0.004	0.002	0.011	0.000
1.000	0.004	0.002	0.011	0.000
1.056	0.004	0.003	0.011	0.000
1.111	0.004	0.003	0.011	0.000
1.167	0.005	0.003	0.012	0.000
1.222	0.005	0.003	0.012	0.000
1.278	0.005	0.004	0.012	0.000
1.333	0.005	0.004	0.013	0.000
1.389	0.006	0.004	0.013	0.000
1.444	0.006	0.004	0.013	0.000
1.500	0.006	0.005	0.013	0.000
1.556	0.006	0.005	0.014	0.000
1.611	0.007	0.006	0.014	0.000
1.667	0.007	0.006	0.014	0.000
1.722	0.007	0.006	0.014	0.000
1.778	0.007	0.007	0.014	0.000
1.833	0.008	0.007	0.015	0.000
1.889	0.008	0.008	0.015	0.000
1.944	0.008	0.008	0.015	0.000
2.000	0.009	0.008	0.015	0.000
2.056	0.009	0.009	0.016	0.000
2.111	0.009	0.009	0.016	0.000
2.167	0.009	0.010	0.016	0.000
2.222	0.010	0.010	0.016	0.000
2.278	0.010	0.011	0.016	0.000
2.333	0.010	0.012	0.017	0.000
2.389	0.011	0.012	0.017	0.000
2.444	0.011	0.013	0.017	0.000
2.500	0.011	0.013	0.017	0.000
2.556	0.012	0.014	0.018	0.000
2.611	0.012	0.015	0.019	0.000
2.667	0.013	0.015	0.020	0.000
2.722	0.013	0.016	0.021	0.000
2.778	0.013	0.017	0.023	0.000
2.833	0.014	0.018	0.024	0.000
2.889	0.014	0.018	0.026	0.000
2.944	0.014	0.019	0.028	0.000
3.000	0.015	0.020	0.030	0.000
3.056	0.015	0.021	0.032	0.000
3.111	0.016	0.022	0.034	0.000
3.167	0.016	0.023	0.036	0.000
3.222	0.016	0.023	0.038	0.000
3.278	0.017	0.024	0.040	0.000
3.333	0.017	0.025	0.042	0.000
3.389	0.018	0.026	0.045	0.000
3.444	0.018	0.027	0.047	0.000
3.500	0.019	0.028	0.049	0.000
3.556	0.019	0.029	0.051	0.000
3.611	0.019	0.030	0.054	0.000
3.667	0.020	0.031	0.057	0.000
3.722	0.020	0.033	0.060	0.000
3.778	0.021	0.034	0.062	0.000
3.833	0.021	0.035	0.065	0.000
3.889	0.022	0.036	0.068	0.000
3.944	0.022	0.037	0.071	0.000
4.000	0.023	0.039	0.074	0.000
4.056	0.023	0.040	0.266	0.000
4.111	0.024	0.041	0.616	0.000
4.167	0.024	0.042	1.069	0.000

4.222	0.025	0.044	1.605	0.000
4.278	0.025	0.045	2.214	0.000
4.333	0.026	0.047	2.887	0.000
4.389	0.026	0.048	3.618	0.000
4.444	0.027	0.049	4.404	0.000
4.500	0.027	0.051	5.241	0.000
4.556	0.028	0.053	6.125	0.000
4.611	0.028	0.054	7.055	0.000
4.667	0.029	0.056	8.028	0.000
4.722	0.029	0.057	9.043	0.000
4.778	0.030	0.059	10.10	0.000
4.833	0.031	0.061	11.19	0.000
4.889	0.031	0.062	12.32	0.000
4.944	0.032	0.064	13.49	0.000
5.000	0.032	0.066	14.69	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.033515
5 year	0.056175
10 year	0.076127
25 year	0.108107
50 year	0.137638
100 year	0.172783

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.022313
5 year	0.033123
10 year	0.041972
25 year	0.055333
50 year	0.067041
100 year	0.080409

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.018	0.016
1950	0.022	0.017
1951	0.042	0.035
1952	0.014	0.014
1953	0.032	0.016
1954	0.038	0.017
1955	0.019	0.015
1956	0.029	0.025
1957	0.136	0.039
1958	0.019	0.014
1959	0.023	0.016
1960	0.200	0.132
1961	0.026	0.024
1962	0.017	0.014
1963	0.118	0.030
1964	0.023	0.018
1965	0.059	0.022
1966	0.061	0.017
1967	0.034	0.018
1968	0.039	0.023
1969	0.088	0.029
1970	0.018	0.015
1971	0.022	0.020
1972	0.027	0.024
1973	0.029	0.016
1974	0.079	0.019
1975	0.025	0.022
1976	0.031	0.017
1977	0.024	0.026

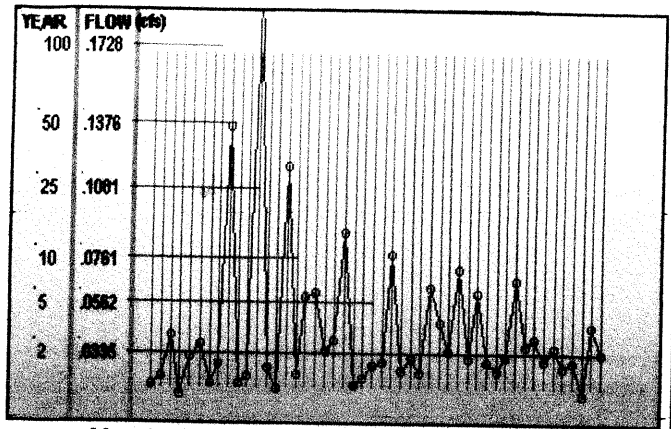
1979	0.048	0.023
1980	0.034	0.032
1981	0.072	0.029
1982	0.031	0.025
1983	0.061	0.062
1984	0.029	0.027
1985	0.025	0.023
1986	0.031	0.026
1987	0.066	0.064
1988	0.037	0.022
1989	0.040	0.017
1990	0.030	0.025
1991	0.036	0.040
1992	0.027	0.027
1993	0.029	0.022
1994	0.015	0.013
1995	0.045	0.035
1996	0.034	0.027

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

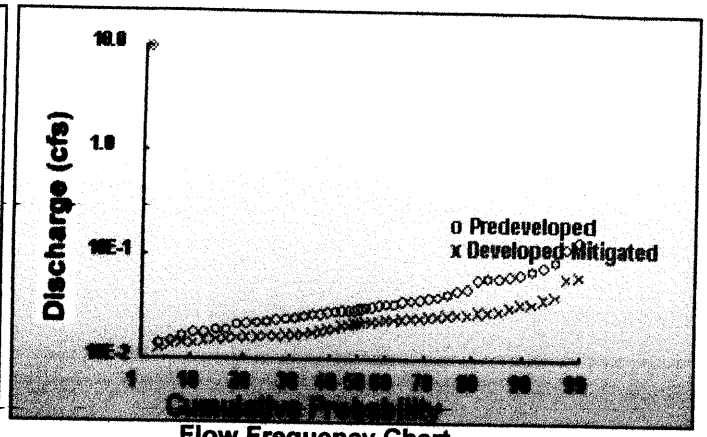
Rank	Predeveloped	Developed
1	0.1360	0.0642
2	0.1179	0.0615
3	0.0877	0.0403
4	0.0785	0.0386
5	0.0716	0.0350
6	0.0663	0.0346
7	0.0630	0.0322
8	0.0609	0.0296
9	0.0607	0.0291
10	0.0590	0.0289
11	0.0475	0.0274
12	0.0455	0.0272
13	0.0419	0.0266
14	0.0402	0.0261
15	0.0391	0.0257
16	0.0377	0.0254
17	0.0368	0.0251
18	0.0360	0.0246
19	0.0341	0.0241
20	0.0340	0.0240
21	0.0337	0.0234
22	0.0315	0.0234
23	0.0314	0.0232
24	0.0310	0.0222
25	0.0308	0.0221
26	0.0299	0.0220
27	0.0293	0.0216
28	0.0292	0.0216
29	0.0290	0.0196
30	0.0285	0.0193
31	0.0274	0.0185
32	0.0270	0.0180
33	0.0264	0.0173
34	0.0254	0.0171
35	0.0247	0.0170
36	0.0238	0.0169
37	0.0234	0.0168
38	0.0226	0.0164
39	0.0225	0.0163
40	0.0217	0.0160
41	0.0193	0.0158
42	0.0192	0.0153
43	0.0183	0.0151
44	0.0181	0.0144
45	0.0166	0.0141
46	0.0147	0.0138
47	0.0141	0.0126

1/2 2 year to 50 year

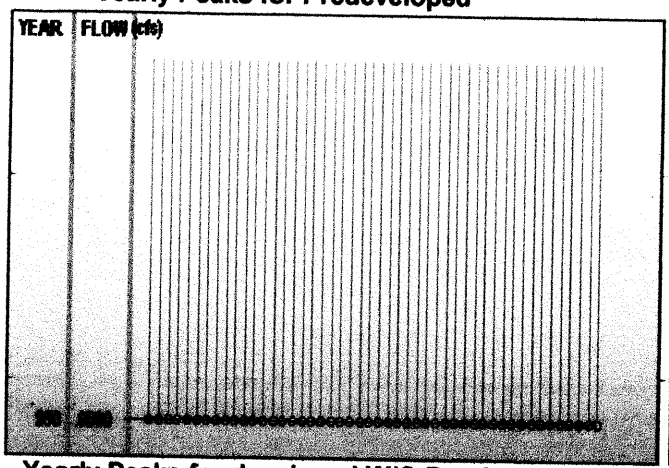
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0168	2564	2373	92.0	Pass
0.0180	1861	1457	78.0	Pass
0.0192	1359	1125	82.0	Pass
0.0204	1031	847	82.0	Pass
0.0216	781	563	72.0	Pass
0.0229	589	422	71.0	Pass
0.0241	440	313	71.0	Pass
0.0253	324	237	73.0	Pass
0.0265	235	176	74.0	Pass
0.0277	179	152	84.0	Pass
0.0290	153	130	84.0	Pass
0.0302	124	112	90.0	Pass
0.0314	105	97	92.0	Pass
0.0326	90	78	86.0	Pass
0.0339	76	66	86.0	Pass
0.0351	67	57	85.0	Pass
0.0363	59	54	91.0	Pass
0.0375	53	50	94.0	Pass
0.0387	48	45	93.0	Pass
0.0400	43	39	90.0	Pass
0.0412	39	34	87.0	Pass
0.0424	35	33	94.0	Pass
0.0436	29	29	100.0	Pass
0.0448	27	26	96.0	Pass
0.0461	23	24	104.0	Pass
0.0473	22	23	104.0	Pass
0.0485	20	21	104.0	Pass
0.0497	19	20	105.0	Pass
0.0509	18	18	100.0	Pass
0.0522	18	15	83.0	Pass
0.0534	18	13	72.0	Pass
0.0546	17	12	70.0	Pass
0.0558	16	11	68.0	Pass
0.0571	16	10	62.0	Pass
0.0583	15	9	60.0	Pass
0.0595	13	8	61.0	Pass
0.0607	12	7	58.0	Pass
0.0619	11	6	54.0	Pass
0.0632	10	6	60.0	Pass
0.0644	10	4	40.0	Pass
0.0656	10	4	40.0	Pass
0.0668	8	4	50.0	Pass
0.0680	8	3	37.0	Pass
0.0693	8	3	37.0	Pass
0.0705	8	2	25.0	Pass
0.0717	7	2	28.0	Pass
0.0729	7	2	28.0	Pass
0.0741	7	2	28.0	Pass
0.0754	7	2	28.0	Pass
0.0766	7	2	28.0	Pass
0.0778	7	2	28.0	Pass
0.0790	6	2	33.0	Pass
0.0803	6	2	33.0	Pass
0.0815	6	2	33.0	Pass
0.0827	6	2	33.0	Pass
0.0839	6	2	33.0	Pass
0.0851	6	2	33.0	Pass
0.0864	6	2	33.0	Pass
0.0876	6	2	33.0	Pass
0.0888	5	2	40.0	Pass
0.0900	5	2	40.0	Pass
0.0912	5	2	40.0	Pass
0.0925	5	2	40.0	Pass
0.0937	5	2	40.0	Pass
0.0949	5	2	40.0	Pass
0.0961	5	2	40.0	Pass
0.0973	5	2	40.0	Pass
0.0986	5	2	40.0	Pass
0.0998	5	2	40.0	Pass
0.1010	5	2	40.0	Pass



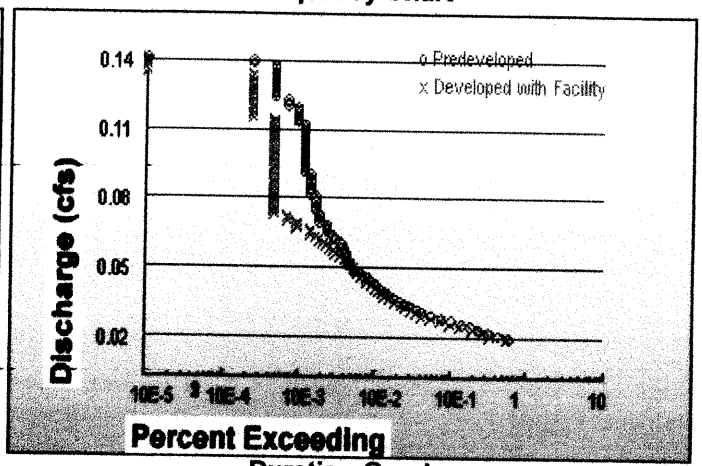
Yearly Peaks for Predeveloped



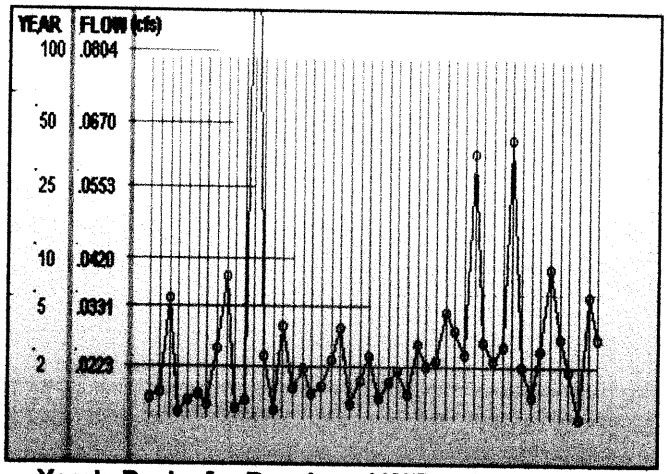
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: pasture
Site Address:
City :
Report Date : 6/10/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00
Pan Evap Factor entered by user: 0

PREDEVELOPED LAND USE

Basin : Basin 1
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.574

DEVELOPED LAND USE
Basin : Basin 1
Flows To : Pond 1
GroundWater: No

Land Use	Acres
TILL PASTURE:	0.574

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 2.4ft.
Bottom Width : 1ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.022 acre-ft.
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.011 ft.
Notch Height: 1.726 ft.
Orifice 1 Diameter: 0.633 in. **Elevation:** 0 ft.

958 cf
95.8 cf / 2500 SF
3.55 cy

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.000	0.000	0.000	0.000
0.056	0.000	0.000	0.002	0.000
0.111	0.000	0.000	0.004	0.000
0.167	0.000	0.000	0.004	0.000

0.222	0.000	0.000	0.005	0.000
0.278	0.000	0.000	0.006	0.000
0.333	0.000	0.000	0.006	0.000
0.389	0.000	0.000	0.007	0.000
0.444	0.000	0.000	0.007	0.000
0.500	0.000	0.000	0.007	0.000
0.556	0.001	0.000	0.008	0.000
0.611	0.001	0.000	0.008	0.000
0.667	0.001	0.000	0.009	0.000
0.722	0.001	0.000	0.009	0.000
0.778	0.001	0.000	0.009	0.000
0.833	0.001	0.000	0.010	0.000
0.889	0.001	0.000	0.010	0.000
0.944	0.001	0.000	0.010	0.000
1.000	0.001	0.001	0.011	0.000
1.056	0.001	0.001	0.011	0.000
1.111	0.002	0.001	0.011	0.000
1.167	0.002	0.001	0.011	0.000
1.222	0.002	0.001	0.012	0.000
1.278	0.002	0.001	0.012	0.000
1.333	0.002	0.001	0.012	0.000
1.389	0.002	0.001	0.012	0.000
1.444	0.002	0.001	0.013	0.000
1.500	0.003	0.002	0.013	0.000
1.556	0.003	0.002	0.013	0.000
1.611	0.003	0.002	0.013	0.000
1.667	0.003	0.002	0.014	0.000
1.722	0.003	0.002	0.014	0.000
1.778	0.003	0.002	0.014	0.000
1.833	0.004	0.003	0.014	0.000
1.889	0.004	0.003	0.014	0.000
1.944	0.004	0.003	0.015	0.000
2.000	0.004	0.003	0.015	0.000
2.056	0.005	0.003	0.015	0.000
2.111	0.005	0.004	0.015	0.000
2.167	0.005	0.004	0.015	0.000
2.222	0.005	0.004	0.016	0.000
2.278	0.005	0.005	0.016	0.000
2.333	0.006	0.005	0.017	0.000
2.389	0.006	0.005	0.018	0.000
2.444	0.006	0.006	0.019	0.000
2.500	0.006	0.006	0.020	0.000
2.556	0.007	0.006	0.022	0.000
2.611	0.007	0.007	0.024	0.000
2.667	0.007	0.007	0.025	0.000
2.722	0.007	0.007	0.027	0.000
2.778	0.008	0.008	0.029	0.000
2.833	0.008	0.008	0.031	0.000
2.889	0.008	0.009	0.033	0.000
2.944	0.009	0.009	0.035	0.000
3.000	0.009	0.010	0.038	0.000
3.056	0.009	0.010	0.040	0.000
3.111	0.010	0.011	0.042	0.000
3.167	0.010	0.011	0.044	0.000
3.222	0.010	0.012	0.046	0.000
3.278	0.010	0.012	0.049	0.000
3.333	0.011	0.013	0.051	0.000
3.389	0.011	0.014	0.054	0.000
3.444	0.011	0.014	0.057	0.000
3.500	0.012	0.015	0.059	0.000
3.556	0.012	0.016	0.062	0.000
3.611	0.013	0.016	0.065	0.000
3.667	0.013	0.017	0.068	0.000
3.722	0.013	0.018	0.071	0.000
3.778	0.014	0.018	0.075	0.000
3.833	0.014	0.019	0.078	0.000
3.889	0.014	0.020	0.081	0.000
3.944	0.015	0.021	0.084	0.000
4.000	0.015	0.022	0.088	0.000
4.056	0.016	0.022	0.279	0.000
4.111	0.016	0.023	0.629	0.000
4.167	0.016	0.024	1.082	0.000

4.222	0.017	0.025	1.618	0.000
4.278	0.017	0.026	2.227	0.000
4.333	0.018	0.027	2.900	0.000
4.389	0.018	0.028	3.631	0.000
4.444	0.018	0.029	4.417	0.000
4.500	0.019	0.030	5.254	0.000
4.556	0.019	0.031	6.138	0.000
4.611	0.020	0.032	7.068	0.000
4.667	0.020	0.033	8.041	0.000
4.722	0.021	0.034	9.056	0.000
4.778	0.021	0.036	10.11	0.000
4.833	0.022	0.037	11.20	0.000
4.889	0.022	0.038	12.33	0.000
4.944	0.023	0.039	13.50	0.000
5.000	0.023	0.041	14.70	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.033515
5 year	0.056175
10 year	0.076127
25 year	0.108107
50 year	0.137638
100 year	0.172783

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.023418
5 year	0.034491
10 year	0.043502
25 year	0.057035
50 year	0.068841
100 year	0.082271

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.018	0.015
1950	0.022	0.019
1951	0.042	0.032
1952	0.014	0.013
1953	0.032	0.016
1954	0.038	0.018
1955	0.019	0.015
1956	0.029	0.027
1957	0.136	0.049
1958	0.019	0.014
1959	0.023	0.017
1960	0.200	0.142
1961	0.026	0.025
1962	0.017	0.013
1963	0.118	0.043
1964	0.023	0.021
1965	0.059	0.023
1966	0.061	0.021
1967	0.034	0.021
1968	0.039	0.025
1969	0.088	0.034
1970	0.018	0.016
1971	0.022	0.021
1972	0.027	0.026
1973	0.029	0.016
1974	0.079	0.028
1975	0.025	0.024
1976	0.031	0.019
1977	0.024	0.025

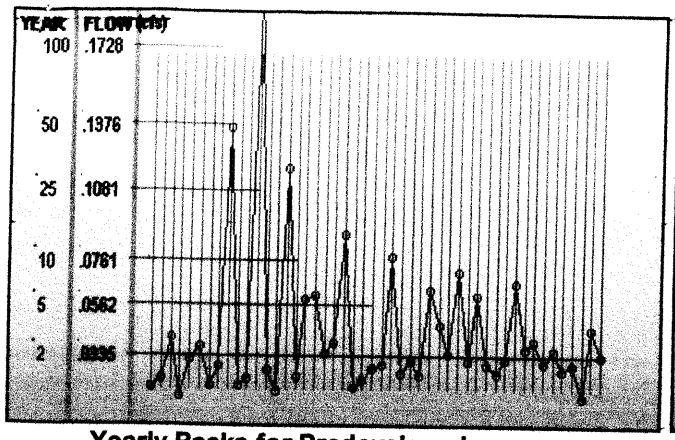
1979	0.048	0.025
1980	0.034	0.033
1981	0.072	0.033
1982	0.031	0.025
1983	0.061	0.047
1984	0.029	0.028
1985	0.025	0.023
1986	0.031	0.028
1987	0.066	0.054
1988	0.037	0.023
1989	0.040	0.019
1990	0.030	0.028
1991	0.036	0.030
1992	0.027	0.027
1993	0.029	0.025
1994	0.015	0.013
1995	0.045	0.033
1996	0.034	0.027

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

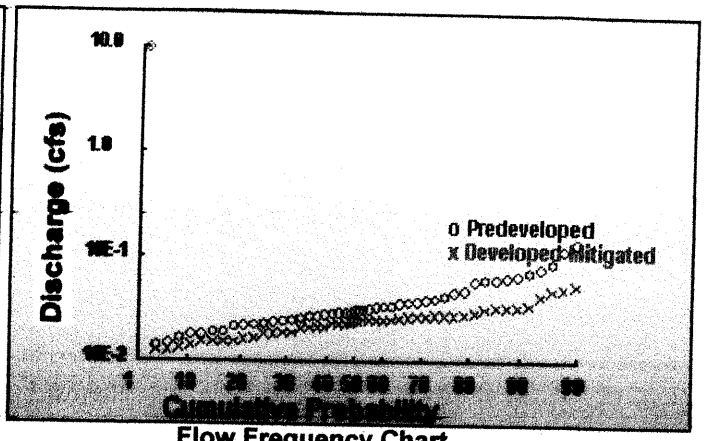
Rank	Predeveloped	Developed
1	0.1360	0.0536
2	0.1179	0.0494
3	0.0877	0.0474
4	0.0785	0.0428
5	0.0716	0.0343
6	0.0663	0.0334
7	0.0630	0.0334
8	0.0609	0.0328
9	0.0607	0.0321
10	0.0590	0.0296
11	0.0475	0.0284
12	0.0455	0.0278
13	0.0419	0.0277
14	0.0402	0.0276
15	0.0391	0.0274
16	0.0377	0.0271
17	0.0368	0.0267
18	0.0360	0.0258
19	0.0341	0.0252
20	0.0340	0.0251
21	0.0337	0.0251
22	0.0315	0.0249
23	0.0314	0.0248
24	0.0310	0.0247
25	0.0308	0.0245
26	0.0299	0.0242
27	0.0293	0.0233
28	0.0292	0.0232
29	0.0290	0.0229
30	0.0285	0.0215
31	0.0274	0.0213
32	0.0270	0.0211
33	0.0264	0.0208
34	0.0254	0.0188
35	0.0247	0.0187
36	0.0238	0.0186
37	0.0234	0.0184
38	0.0226	0.0168
39	0.0225	0.0163
40	0.0217	0.0156
41	0.0193	0.0155
42	0.0192	0.0154
43	0.0183	0.0153
44	0.0181	0.0142
45	0.0166	0.0134
46	0.0147	0.0128
47	0.0141	0.0128

1/2 2 year to 50 year

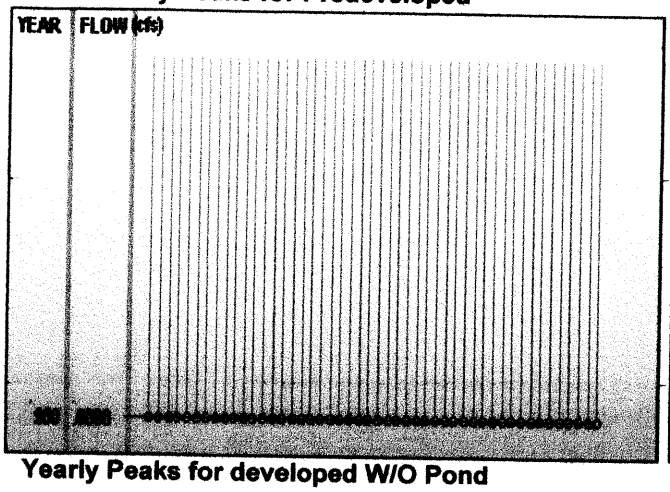
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0168	2564	2158	84.0	Pass
0.0180	1861	1687	90.0	Pass
0.0192	1359	1252	92.0	Pass
0.0204	1031	936	90.0	Pass
0.0216	781	714	91.0	Pass
0.0229	589	535	90.0	Pass
0.0241	440	390	88.0	Pass
0.0253	324	286	88.0	Pass
0.0265	235	199	84.0	Pass
0.0277	179	152	84.0	Pass
0.0290	153	128	83.0	Pass
0.0302	124	109	87.0	Pass
0.0314	105	90	85.0	Pass
0.0326	90	70	77.0	Pass
0.0339	76	56	73.0	Pass
0.0351	67	50	74.0	Pass
0.0363	59	44	74.0	Pass
0.0375	53	39	73.0	Pass
0.0387	48	34	70.0	Pass
0.0400	43	30	69.0	Pass
0.0412	39	27	69.0	Pass
0.0424	35	23	65.0	Pass
0.0436	29	21	72.0	Pass
0.0448	27	16	59.0	Pass
0.0461	23	15	65.0	Pass
0.0473	22	13	59.0	Pass
0.0485	20	11	55.0	Pass
0.0497	19	7	36.0	Pass
0.0509	18	6	33.0	Pass
0.0522	18	5	27.0	Pass
0.0534	18	4	22.0	Pass
0.0546	17	3	17.0	Pass
0.0558	16	2	12.0	Pass
0.0571	16	2	12.0	Pass
0.0583	15	2	13.0	Pass
0.0595	13	2	15.0	Pass
0.0607	12	2	16.0	Pass
0.0619	11	2	18.0	Pass
0.0632	10	2	20.0	Pass
0.0644	10	2	20.0	Pass
0.0656	10	2	20.0	Pass
0.0668	8	2	25.0	Pass
0.0680	8	2	25.0	Pass
0.0693	8	2	25.0	Pass
0.0705	8	2	25.0	Pass
0.0717	7	2	28.0	Pass
0.0729	7	2	28.0	Pass
0.0741	7	2	28.0	Pass
0.0754	7	2	28.0	Pass
0.0766	7	2	28.0	Pass
0.0778	7	2	28.0	Pass
0.0790	6	2	33.0	Pass
0.0803	6	2	33.0	Pass
0.0815	6	2	33.0	Pass
0.0827	6	2	33.0	Pass
0.0839	6	2	33.0	Pass
0.0851	6	2	33.0	Pass
0.0864	6	2	33.0	Pass
0.0876	6	2	33.0	Pass
0.0888	5	2	40.0	Pass
0.0900	5	2	40.0	Pass
0.0912	5	2	40.0	Pass
0.0925	5	2	40.0	Pass
0.0937	5	2	40.0	Pass
0.0949	5	2	40.0	Pass
0.0961	5	2	40.0	Pass
0.0973	5	2	40.0	Pass
0.0986	5	2	40.0	Pass
0.0998	5	2	40.0	Pass
0.1010	5	2	40.0	Pass
0.1022	5	2	40.0	Pass



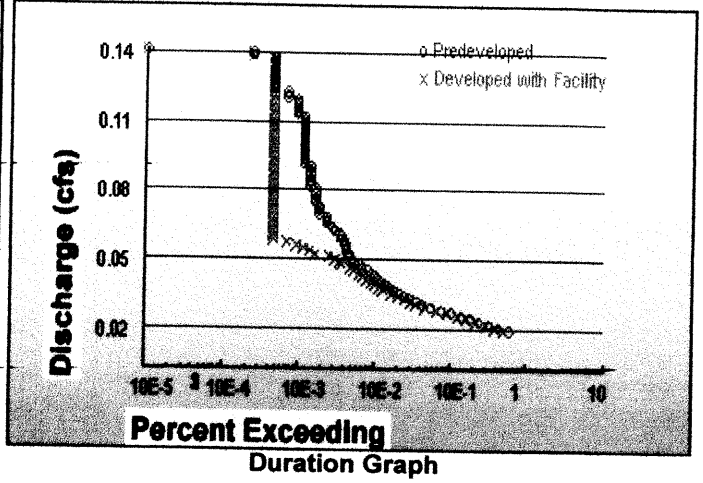
Yearly Peaks for Predeveloped



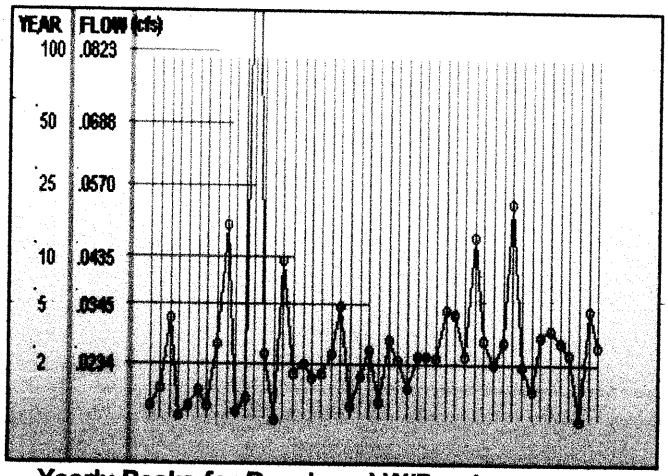
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX F

WWHM Output for Green Roof vs. Standard Roof

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: Roof(imp)
Site Address:
City :
Report Date : 6/9/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.23

DEVELOPED LAND USE
Basin : Dev
Flows To : Pond 1
GroundWater: No

Land Use	Acres
IMPERVIOUS:	0.23

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 37.84ft.
Bottom Width : 12.56ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.117 acre-ft. 5097 cf → 188.78 cy
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 0.464 ft.
Orifice 1 Diameter: 0.23533 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.011	0.000	0.000	0.000
0.056	0.011	0.001	0.000	0.000
0.111	0.012	0.001	0.000	0.000
0.167	0.012	0.002	0.001	0.000
0.222	0.012	0.003	0.001	0.000

0.278	0.013	0.003	0.001	0.000
0.333	0.013	0.004	0.001	0.000
0.389	0.014	0.005	0.001	0.000
0.444	0.014	0.006	0.001	0.000
0.500	0.015	0.006	0.001	0.000
0.556	0.015	0.007	0.001	0.000
0.611	0.015	0.008	0.001	0.000
0.667	0.016	0.009	0.001	0.000
0.722	0.016	0.010	0.001	0.000
0.778	0.017	0.011	0.001	0.000
0.833	0.017	0.012	0.001	0.000
0.889	0.018	0.013	0.001	0.000
0.944	0.018	0.014	0.001	0.000
1.000	0.019	0.015	0.001	0.000
1.056	0.019	0.016	0.001	0.000
1.111	0.020	0.017	0.002	0.000
1.167	0.020	0.018	0.002	0.000
1.222	0.021	0.019	0.002	0.000
1.278	0.021	0.020	0.002	0.000
1.333	0.022	0.021	0.002	0.000
1.389	0.022	0.023	0.002	0.000
1.444	0.023	0.024	0.002	0.000
1.500	0.023	0.025	0.002	0.000
1.556	0.024	0.026	0.002	0.000
1.611	0.024	0.028	0.002	0.000
1.667	0.025	0.029	0.002	0.000
1.722	0.025	0.030	0.002	0.000
1.778	0.026	0.032	0.002	0.000
1.833	0.026	0.033	0.002	0.000
1.889	0.027	0.035	0.002	0.000
1.944	0.028	0.036	0.002	0.000
2.000	0.028	0.038	0.002	0.000
2.056	0.029	0.039	0.002	0.000
2.111	0.029	0.041	0.002	0.000
2.167	0.030	0.043	0.002	0.000
2.222	0.030	0.044	0.002	0.000
2.278	0.031	0.046	0.002	0.000
2.333	0.032	0.048	0.002	0.000
2.389	0.032	0.050	0.002	0.000
2.444	0.033	0.051	0.002	0.000
2.500	0.033	0.053	0.002	0.000
2.556	0.034	0.055	0.002	0.000
2.611	0.035	0.057	0.002	0.000
2.667	0.035	0.059	0.002	0.000
2.722	0.036	0.061	0.002	0.000
2.778	0.037	0.063	0.002	0.000
2.833	0.037	0.065	0.002	0.000
2.889	0.038	0.067	0.002	0.000
2.944	0.039	0.069	0.002	0.000
3.000	0.039	0.071	0.003	0.000
3.056	0.040	0.074	0.003	0.000
3.111	0.041	0.076	0.003	0.000
3.167	0.041	0.078	0.003	0.000
3.222	0.042	0.080	0.003	0.000
3.278	0.043	0.083	0.003	0.000
3.333	0.043	0.085	0.003	0.000
3.389	0.044	0.088	0.003	0.000
3.444	0.045	0.090	0.003	0.000
3.500	0.045	0.093	0.003	0.000
3.556	0.046	0.095	0.003	0.000
3.611	0.047	0.098	0.003	0.000
3.667	0.047	0.100	0.004	0.000
3.722	0.048	0.103	0.005	0.000
3.778	0.049	0.106	0.007	0.000
3.833	0.050	0.108	0.008	0.000
3.889	0.050	0.111	0.010	0.000
3.944	0.051	0.114	0.011	0.000
4.000	0.052	0.117	0.013	0.000
4.056	0.053	0.120	0.204	0.000
4.111	0.053	0.123	0.554	0.000
4.167	0.054	0.126	1.007	0.000
4.222	0.055	0.129	1.543	0.000

4.278	0.056	0.132	2.152	0.000
4.333	0.057	0.135	2.824	0.000
4.389	0.057	0.138	3.556	0.000
4.444	0.058	0.141	4.341	0.000
4.500	0.059	0.144	5.178	0.000
4.556	0.060	0.148	6.062	0.000
4.611	0.060	0.151	6.992	0.000
4.667	0.061	0.155	7.965	0.000
4.722	0.062	0.158	8.979	0.000
4.778	0.063	0.161	10.03	0.000
4.833	0.064	0.165	11.13	0.000
4.889	0.065	0.168	12.26	0.000
4.944	0.065	0.172	13.42	0.000
5.000	0.066	0.176	14.62	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.005062
5 year	0.008492
10 year	0.011064
25 year	0.014607
50 year	0.017437
100 year	0.020415

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.002807
5 year	0.00435
10 year	0.005657
25 year	0.007686
50 year	0.009509
100 year	0.011634

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.007	0.003
1950	0.006	0.003
1951	0.012	0.010
1952	0.003	0.002
1953	0.004	0.007
1954	0.004	0.002
1955	0.004	0.002
1956	0.008	0.007
1957	0.003	0.002
1958	0.003	0.002
1959	0.004	0.003
1960	0.022	0.003
1961	0.006	0.012
1962	0.002	0.002
1963	0.015	0.003
1964	0.006	0.003
1965	0.005	0.003
1966	0.014	0.002
1967	0.007	0.002
1968	0.003	0.002
1969	0.004	0.002
1970	0.003	0.003
1971	0.005	0.003
1972	0.008	0.005
1973	0.003	0.003
1974	0.010	0.002
1975	0.006	0.003
1976	0.006	0.003
1977	0.001	0.002
1978	0.012	0.003

1980	0.008	0.005
1981	0.004	0.003
1982	0.007	0.005
1983	0.004	0.002
1984	0.002	0.002
1985	0.003	0.003
1986	0.005	0.002
1987	0.013	0.014
1988	0.004	0.002
1989	0.003	0.003
1990	0.007	0.007
1991	0.006	0.002
1992	0.004	0.002
1993	0.007	0.002
1994	0.002	0.002
1995	0.002	0.002
1996	0.007	0.003

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

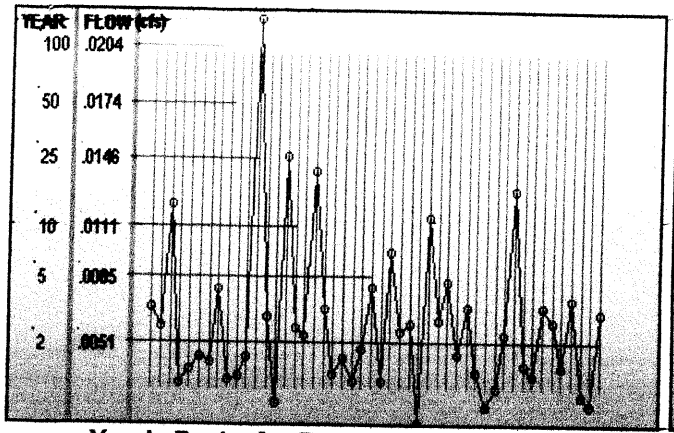
Rank	Predeveloped	Developed
1	0.0147	0.0122
2	0.0139	0.0104
3	0.0130	0.0074
4	0.0122	0.0068
5	0.0116	0.0068
6	0.0098	0.0051
7	0.0083	0.0048
8	0.0079	0.0047
9	0.0078	0.0027
10	0.0073	0.0027
11	0.0069	0.0026
12	0.0069	0.0026
13	0.0069	0.0026
14	0.0068	0.0026
15	0.0066	0.0026
16	0.0064	0.0026
17	0.0062	0.0025
18	0.0062	0.0025
19	0.0061	0.0025
20	0.0060	0.0025
21	0.0058	0.0025
22	0.0056	0.0025
23	0.0055	0.0025
24	0.0055	0.0025
25	0.0047	0.0025
26	0.0044	0.0025
27	0.0044	0.0025
28	0.0044	0.0025
29	0.0042	0.0025
30	0.0040	0.0025
31	0.0039	0.0024
32	0.0037	0.0024
33	0.0037	0.0024
34	0.0035	0.0024
35	0.0034	0.0023
36	0.0033	0.0023
37	0.0033	0.0023
38	0.0031	0.0023
39	0.0030	0.0022
40	0.0030	0.0022
41	0.0030	0.0022
42	0.0026	0.0022
43	0.0022	0.0021
44	0.0019	0.0021
45	0.0018	0.0021
46	0.0017	0.0020
47	0.0009	0.0019

1/2 2 year to 50 year
Flow(CFS) Predev Final Percentage Pass/Fail

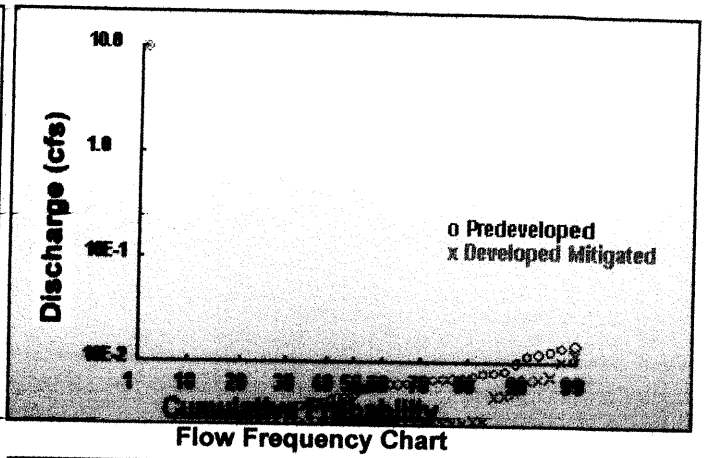
0.0025	4173	3925	94.0	Pass
0.0027	3630	1667	45.0	Pass
0.0028	3165	794	25.0	Pass
0.0030	2780	719	25.0	Pass
0.0031	2463	663	26.0	Pass
0.0033	2202	619	28.0	Pass
0.0034	1991	574	28.0	Pass
0.0036	1805	527	29.0	Pass
0.0037	1620	496	30.0	Pass
0.0039	1456	460	31.0	Pass
0.0040	1310	418	31.0	Pass
0.0042	1173	373	31.0	Pass
0.0043	1054	334	31.0	Pass
0.0045	937	305	32.0	Pass
0.0046	842	274	32.0	Pass
0.0048	746	247	33.0	Pass
0.0049	667	228	34.0	Pass
0.0051	602	202	33.0	Pass
0.0052	542	188	34.0	Pass
0.0054	480	178	37.0	Pass
0.0055	433	168	38.0	Pass
0.0057	378	151	39.0	Pass
0.0058	332	138	41.0	Pass
0.0060	293	131	44.0	Pass
0.0061	261	120	45.0	Pass
0.0063	236	108	45.0	Pass
0.0064	209	92	44.0	Pass
0.0066	184	83	45.0	Pass
0.0067	171	75	43.0	Pass
0.0069	157	68	43.0	Pass
0.0070	143	63	44.0	Pass
0.0072	129	59	45.0	Pass
0.0073	120	54	45.0	Pass
0.0075	114	51	44.0	Pass
0.0077	105	50	47.0	Pass
0.0078	95	47	49.0	Pass
0.0080	89	45	50.0	Pass
0.0081	80	44	55.0	Pass
0.0083	72	42	58.0	Pass
0.0084	65	41	63.0	Pass
0.0086	60	38	63.0	Pass
0.0087	56	37	66.0	Pass
0.0089	50	35	70.0	Pass
0.0090	47	34	72.0	Pass
0.0092	46	31	67.0	Pass
0.0093	42	30	71.0	Pass
0.0095	39	30	76.0	Pass
0.0096	36	27	75.0	Pass
0.0098	34	24	70.0	Pass
0.0099	31	23	74.0	Pass
0.0101	29	20	68.0	Pass
0.0102	26	19	73.0	Pass
0.0104	24	17	70.0	Pass
0.0105	23	14	60.0	Pass
0.0107	22	14	63.0	Pass
0.0108	18	13	72.0	Pass
0.0110	17	12	70.0	Pass
0.0111	14	12	85.0	Pass
0.0113	12	11	91.0	Pass
0.0114	10	10	100.0	Pass
0.0116	10	9	90.0	Pass
0.0117	8	8	100.0	Pass
0.0119	8	6	75.0	Pass
0.0120	7	5	71.0	Pass
0.0122	7	4	57.0	Pass
0.0123	6	2	33.0	Pass
0.0125	5	2	40.0	Pass
0.0126	5	2	40.0	Pass
0.0128	5	2	40.0	Pass
0.0129	4	2	50.0	Pass
0.0131	3	2	66.0	Pass
0.0132	3	2	66.0	Pass

0.0134	3	2	66.0	Pass
0.0135	3	2	66.0	Pass
0.0137	3	2	66.0	Pass
0.0138	3	2	66.0	Pass
0.0140	2	2	100.0	Pass
0.0141	2	2	100.0	Pass
0.0143	2	1	50.0	Pass
0.0144	2	0	.0	Pass
0.0146	2	0	.0	Pass
0.0147	1	0	.0	Pass
0.0149	1	0	.0	Pass
0.0150	1	0	.0	Pass
0.0152	1	0	.0	Pass
0.0153	1	0	.0	Pass
0.0155	1	0	.0	Pass
0.0156	1	0	.0	Pass
0.0158	1	0	.0	Pass
0.0159	1	0	.0	Pass
0.0161	1	0	.0	Pass
0.0162	1	0	.0	Pass
0.0164	1	0	.0	Pass
0.0165	1	0	.0	Pass
0.0167	1	0	.0	Pass
0.0168	1	0	.0	Pass
0.0170	1	0	.0	Pass
0.0171	1	0	.0	Pass
0.0173	1	0	.0	Pass
0.0174	1	0	.0	Pass

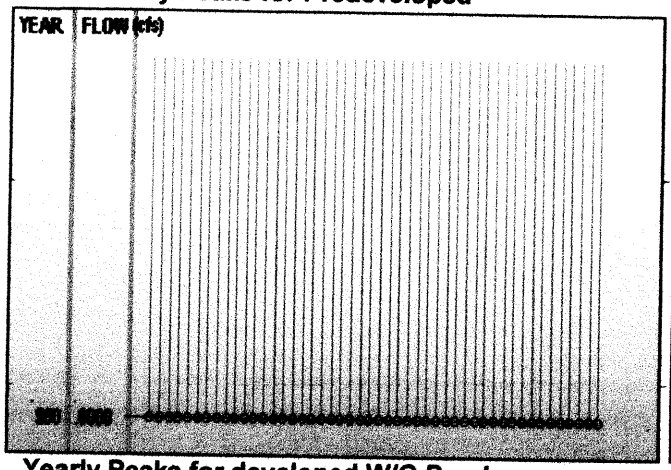
Water Quality BMP Flow and Volume.
On-line facility volume: ~~0.004~~ acre-feet **0.025**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**



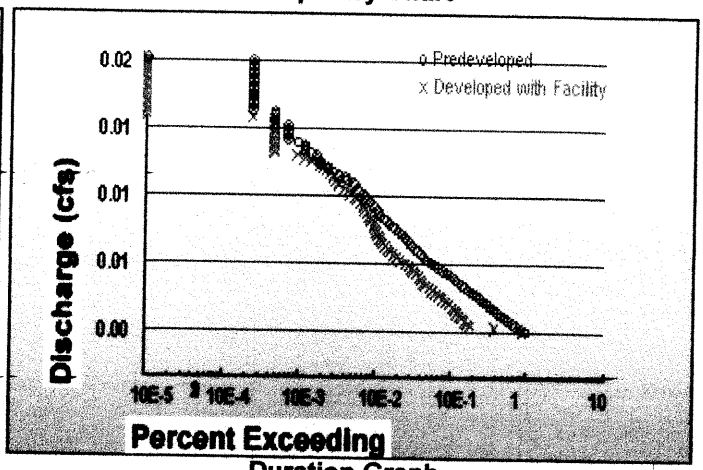
Yearly Peaks for Predeveloped



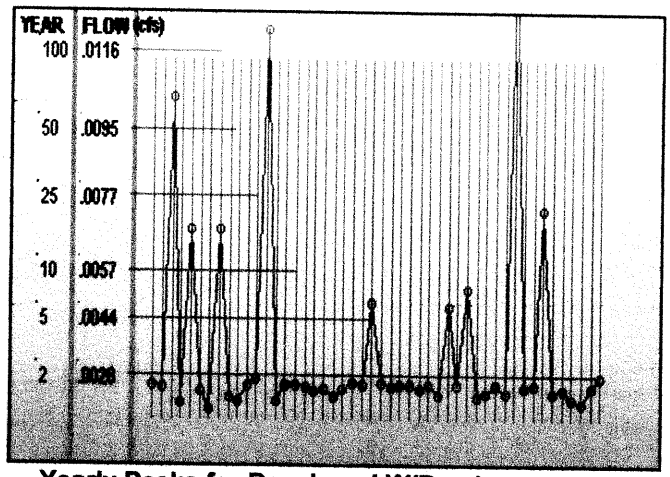
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

WESTERN WASHINGTON HYDROLOGY MODEL V2
PROJECT REPORT

Project Name: Green Roof
Site Address:
City :
Report Date : 6/9/2004
Gage : McMillian
Data Start : 1948
Data End : 1996
Precip Scale: 1.00

PREDEVELOPED LAND USE

Basin : Pre-Dev
Flows To : Point of Compliance
GroundWater: No

Land Use	Acres
TILL FOREST:	0.23

DEVELOPED LAND USE
Basin : Dev
Flows To : Pond 1
GroundWater: No

Land Use	Acres
TILL GRASS:	0.23

RCHRES (POND) INFORMATION
Pond Name: Pond 1
Pond Type: Trapezoidal Pond
Pond Flows to : Point of Compliance
Pond Rain / Evap is not activated.
Dimensions
Depth: 5ft.
Bottom Length: 9.9ft.
Bottom Width : 3.2ft.
Side slope 1: 3 To 1
Side slope 2: 3 To 1
Side slope 3: 3 To 1
Side slope 4: 3 To 1
Volume at Riser Head: 0.035 acre-ft. 1525 cf → 56.48 cy
Discharge Structure
Riser Height: 4 ft.
Riser Diameter: 18 in.
NotchType : Rectangular
Notch Width : 0.010 ft.
Notch Height: 0.440 ft.
Orifice 1 Diameter: 0.232 in. **Elevation:** 0 ft.

Pond Hydraulic Table

Stage(ft)	Area(acr)	Volume(acr-ft)	Dschrg(cfs)	Infilt(cfs)
0.000	0.001	0.000	0.000	0.000
0.056	0.001	0.000	0.000	0.000
0.111	0.001	0.000	0.000	0.000
0.167	0.001	0.000	0.001	0.000
0.222	0.001	0.000	0.001	0.000

0.278	0.001	0.000	0.001	0.000
0.333	0.001	0.000	0.001	0.000
0.389	0.002	0.000	0.001	0.000
0.444	0.002	0.001	0.001	0.000
0.500	0.002	0.001	0.001	0.000
0.556	0.002	0.001	0.001	0.000
0.611	0.002	0.001	0.001	0.000
0.667	0.002	0.001	0.001	0.000
0.722	0.002	0.001	0.001	0.000
0.778	0.003	0.001	0.001	0.000
0.833	0.003	0.001	0.001	0.000
0.889	0.003	0.002	0.001	0.000
0.944	0.003	0.002	0.001	0.000
1.000	0.003	0.002	0.001	0.000
1.056	0.004	0.002	0.001	0.000
1.111	0.004	0.002	0.001	0.000
1.167	0.004	0.003	0.002	0.000
1.222	0.004	0.003	0.002	0.000
1.278	0.004	0.003	0.002	0.000
1.333	0.005	0.003	0.002	0.000
1.389	0.005	0.003	0.002	0.000
1.444	0.005	0.004	0.002	0.000
1.500	0.005	0.004	0.002	0.000
1.556	0.006	0.004	0.002	0.000
1.611	0.006	0.005	0.002	0.000
1.667	0.006	0.005	0.002	0.000
1.722	0.006	0.005	0.002	0.000
1.778	0.007	0.006	0.002	0.000
1.833	0.007	0.006	0.002	0.000
1.889	0.007	0.006	0.002	0.000
1.944	0.007	0.007	0.002	0.000
2.000	0.008	0.007	0.002	0.000
2.056	0.008	0.008	0.002	0.000
2.111	0.008	0.008	0.002	0.000
2.167	0.009	0.009	0.002	0.000
2.222	0.009	0.009	0.002	0.000
2.278	0.009	0.010	0.002	0.000
2.333	0.009	0.010	0.002	0.000
2.389	0.010	0.011	0.002	0.000
2.444	0.010	0.011	0.002	0.000
2.500	0.010	0.012	0.002	0.000
2.556	0.011	0.012	0.002	0.000
2.611	0.011	0.013	0.002	0.000
2.667	0.011	0.014	0.002	0.000
2.722	0.012	0.014	0.002	0.000
2.778	0.012	0.015	0.002	0.000
2.833	0.012	0.016	0.002	0.000
2.889	0.013	0.016	0.002	0.000
2.944	0.013	0.017	0.002	0.000
3.000	0.014	0.018	0.002	0.000
3.056	0.014	0.019	0.002	0.000
3.111	0.014	0.019	0.002	0.000
3.167	0.015	0.020	0.003	0.000
3.222	0.015	0.021	0.003	0.000
3.278	0.016	0.022	0.003	0.000
3.333	0.016	0.023	0.003	0.000
3.389	0.016	0.024	0.003	0.000
3.444	0.017	0.024	0.003	0.000
3.500	0.017	0.025	0.003	0.000
3.556	0.018	0.026	0.003	0.000
3.611	0.018	0.027	0.003	0.000
3.667	0.018	0.028	0.004	0.000
3.722	0.019	0.029	0.005	0.000
3.778	0.019	0.030	0.006	0.000
3.833	0.020	0.032	0.007	0.000
3.889	0.020	0.033	0.009	0.000
3.944	0.021	0.034	0.010	0.000
4.000	0.021	0.035	0.012	0.000
4.056	0.022	0.036	0.203	0.000
4.111	0.022	0.037	0.553	0.000
4.167	0.023	0.039	1.006	0.000
4.222	0.023	0.040	1.542	0.000

4.278	0.024	0.041	2.151	0.000
4.333	0.024	0.043	2.823	0.000
4.389	0.025	0.044	3.555	0.000
4.444	0.025	0.045	4.340	0.000
4.500	0.026	0.047	5.177	0.000
4.556	0.026	0.048	6.061	0.000
4.611	0.027	0.050	6.991	0.000
4.667	0.027	0.051	7.964	0.000
4.722	0.028	0.053	8.978	0.000
4.778	0.028	0.054	10.03	0.000
4.833	0.029	0.056	11.13	0.000
4.889	0.029	0.057	12.25	0.000
4.944	0.030	0.059	13.42	0.000
5.000	0.030	0.061	14.62	0.000

ANALYSIS RESULTS

Flow Frequency Return Periods for Predeveloped

Return Period	Flow(cfs)
2 year	0.005062
5 year	0.008492
10 year	0.011064
25 year	0.014607
50 year	0.017437
100 year	0.020415

Flow Frequency Return Periods for Developed Unmitigated

Return Period	Flow(cfs)
2 year	0.014612
5 year	0.025071
10 year	0.034044
25 year	0.048054
50 year	0.060658
100 year	0.075321

Flow Frequency Return Periods for Developed Mitigated

Return Period	Flow(cfs)
2 year	0.002766
5 year	0.004178
10 year	0.005348
25 year	0.007136
50 year	0.008718
100 year	0.010539

Yearly Peaks for Predeveloped and Developed-Mitigated

Year	Predeveloped	Developed
1949	0.007	0.002
1950	0.006	0.003
1951	0.012	0.010
1952	0.003	0.002
1953	0.004	0.003
1954	0.004	0.002
1955	0.004	0.002
1956	0.008	0.003
1957	0.003	0.002
1958	0.003	0.002
1959	0.004	0.002
1960	0.022	0.007
1961	0.006	0.007
1962	0.002	0.002
1963	0.015	0.003
1964	0.006	0.002
1965	0.005	0.003
1966	0.014	0.002
1967	0.007	0.002
1968	0.003	0.002
1969	0.004	0.002

1970	0.003	0.002
1971	0.005	0.002
1972	0.008	0.006
1973	0.003	0.003
1974	0.010	0.002
1975	0.006	0.003
1976	0.006	0.003
1977	0.001	0.002
1978	0.012	0.002
1979	0.006	0.002
1980	0.008	0.007
1981	0.004	0.003
1982	0.007	0.006
1983	0.004	0.002
1984	0.002	0.002
1985	0.003	0.002
1986	0.005	0.002
1987	0.013	0.014
1988	0.004	0.002
1989	0.003	0.002
1990	0.007	0.005
1991	0.006	0.003
1992	0.004	0.003
1993	0.007	0.002
1994	0.002	0.002
1995	0.002	0.002
1996	0.007	0.005

Ranked Yearly Peaks for Predeveloped and Developed-Mitigated

Rank	Predeveloped	Developed
1	0.0147	0.0099
2	0.0139	0.0075
3	0.0130	0.0072
4	0.0122	0.0066
5	0.0116	0.0062
6	0.0098	0.0058
7	0.0083	0.0051
8	0.0079	0.0048
9	0.0078	0.0030
10	0.0073	0.0026
11	0.0069	0.0026
12	0.0069	0.0026
13	0.0069	0.0026
14	0.0068	0.0026
15	0.0066	0.0025
16	0.0064	0.0025
17	0.0062	0.0025
18	0.0062	0.0025
19	0.0061	0.0025
20	0.0060	0.0025
21	0.0058	0.0025
22	0.0056	0.0025
23	0.0055	0.0025
24	0.0055	0.0025
25	0.0047	0.0025
26	0.0044	0.0025
27	0.0044	0.0025
28	0.0044	0.0024
29	0.0042	0.0024
30	0.0040	0.0024
31	0.0039	0.0024
32	0.0037	0.0024
33	0.0037	0.0024
34	0.0035	0.0024
35	0.0034	0.0023
36	0.0033	0.0023
37	0.0033	0.0023
38	0.0031	0.0023
39	0.0030	0.0023
40	0.0030	0.0023
41	0.0030	0.0022

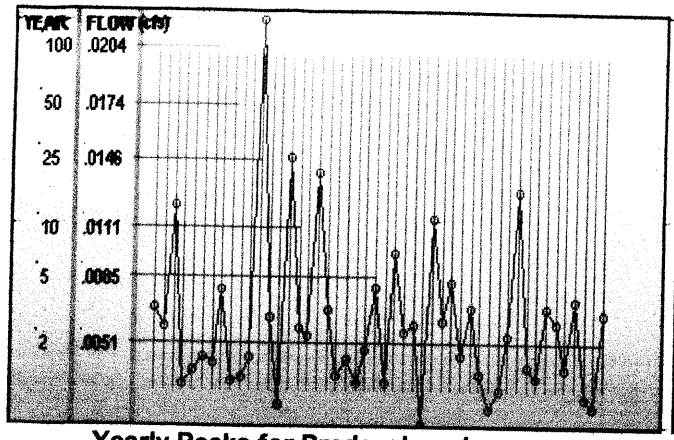
42	0.0026	0.0021
43	0.0022	0.0021
44	0.0019	0.0020
45	0.0018	0.0020
46	0.0017	0.0019
47	0.0009	0.0019

1/2 2 year to 50 year

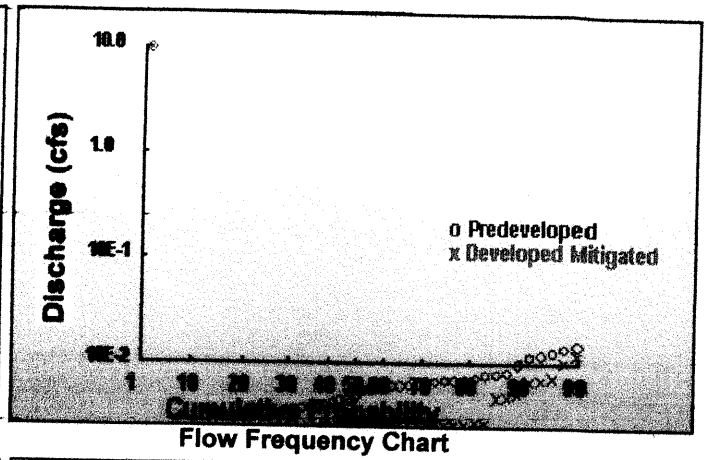
Flow(CFS)	Predev	Final	Percentage	Pass/Fail
0.0025	4173	2676	64.0	Pass
0.0027	3630	944	26.0	Pass
0.0028	3165	883	27.0	Pass
0.0030	2780	823	29.0	Pass
0.0031	2463	770	31.0	Pass
0.0033	2202	740	33.0	Pass
0.0034	1991	717	36.0	Pass
0.0036	1805	690	38.0	Pass
0.0037	1620	659	40.0	Pass
0.0039	1456	629	43.0	Pass
0.0040	1310	604	46.0	Pass
0.0042	1173	570	48.0	Pass
0.0043	1054	535	50.0	Pass
0.0045	937	504	53.0	Pass
0.0046	842	467	55.0	Pass
0.0048	746	427	57.0	Pass
0.0049	667	394	59.0	Pass
0.0051	602	354	58.0	Pass
0.0052	542	319	58.0	Pass
0.0054	480	289	60.0	Pass
0.0055	433	264	60.0	Pass
0.0057	378	236	62.0	Pass
0.0058	332	215	64.0	Pass
0.0060	293	193	65.0	Pass
0.0061	261	176	67.0	Pass
0.0063	236	158	66.0	Pass
0.0064	209	145	69.0	Pass
0.0066	184	120	65.0	Pass
0.0067	171	112	65.0	Pass
0.0069	157	104	66.0	Pass
0.0070	143	96	67.0	Pass
0.0072	129	81	62.0	Pass
0.0073	120	75	62.0	Pass
0.0075	114	66	57.0	Pass
0.0077	105	64	60.0	Pass
0.0078	95	63	66.0	Pass
0.0080	89	61	68.0	Pass
0.0081	80	59	73.0	Pass
0.0083	72	57	79.0	Pass
0.0084	65	54	83.0	Pass
0.0086	60	53	88.0	Pass
0.0087	56	51	91.0	Pass
0.0089	50	48	96.0	Pass
0.0090	47	45	95.0	Pass
0.0092	46	42	91.0	Pass
0.0093	42	39	92.0	Pass
0.0095	39	37	94.0	Pass
0.0096	36	34	94.0	Pass
0.0098	34	31	91.0	Pass
0.0099	31	23	74.0	Pass
0.0101	29	22	75.0	Pass
0.0102	26	22	84.0	Pass
0.0104	24	21	87.0	Pass
0.0105	23	19	82.0	Pass
0.0107	22	18	81.0	Pass
0.0108	18	17	94.0	Pass
0.0110	17	15	88.0	Pass
0.0111	14	14	100.0	Pass
0.0113	12	13	108.0	Pass
0.0114	10	11	110.0	Pass
0.0116	10	10	100.0	Pass
0.0117	8	7	87.0	Pass

0.0119	8	7	87.0	Pass
0.0120	7	7	100.0	Pass
0.0122	7	5	71.0	Pass
0.0123	6	4	66.0	Pass
0.0125	5	4	80.0	Pass
0.0126	5	4	80.0	Pass
0.0128	5	3	60.0	Pass
0.0129	4	2	50.0	Pass
0.0131	3	2	66.0	Pass
0.0132	3	2	66.0	Pass
0.0134	3	2	66.0	Pass
0.0135	3	1	33.0	Pass
0.0137	3	0	.0	Pass
0.0138	3	0	.0	Pass
0.0140	2	0	.0	Pass
0.0141	2	0	.0	Pass
0.0143	2	0	.0	Pass
0.0144	2	0	.0	Pass
0.0146	2	0	.0	Pass
0.0147	1	0	.0	Pass
0.0149	1	0	.0	Pass
0.0150	1	0	.0	Pass
0.0152	1	0	.0	Pass
0.0153	1	0	.0	Pass
0.0155	1	0	.0	Pass
0.0156	1	0	.0	Pass
0.0158	1	0	.0	Pass
0.0159	1	0	.0	Pass
0.0161	1	0	.0	Pass
0.0162	1	0	.0	Pass
0.0164	1	0	.0	Pass
0.0165	1	0	.0	Pass
0.0167	1	0	.0	Pass
0.0168	1	0	.0	Pass
0.0170	1	0	.0	Pass
0.0171	1	0	.0	Pass
0.0173	1	0	.0	Pass
0.0174	1	0	.0	Pass

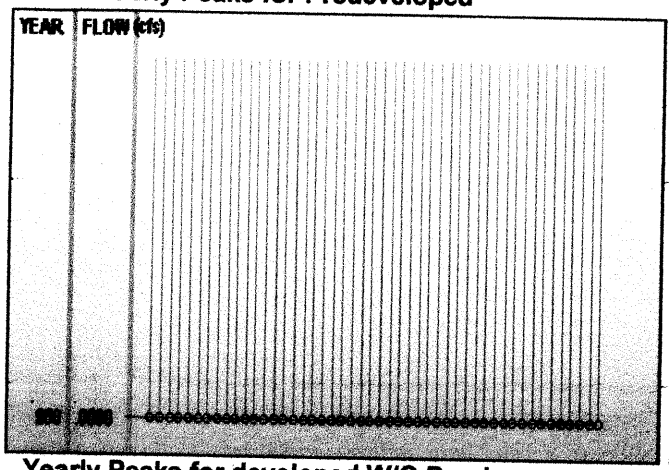
Water Quality BMP Flow and Volume.
On-line facility volume: 0.01 acre-feet
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**



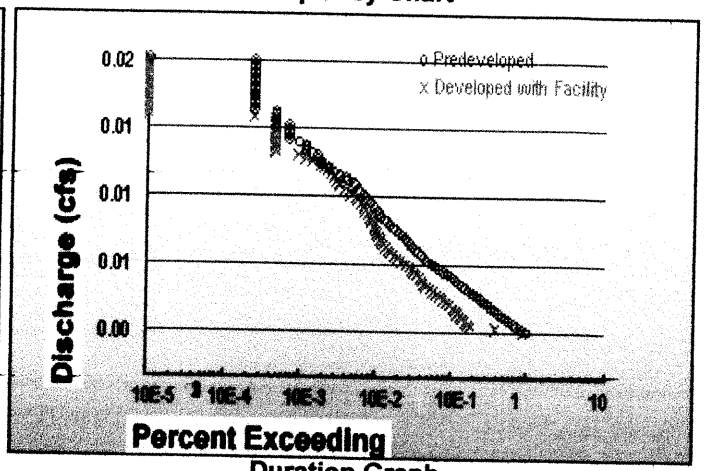
Yearly Peaks for Predeveloped



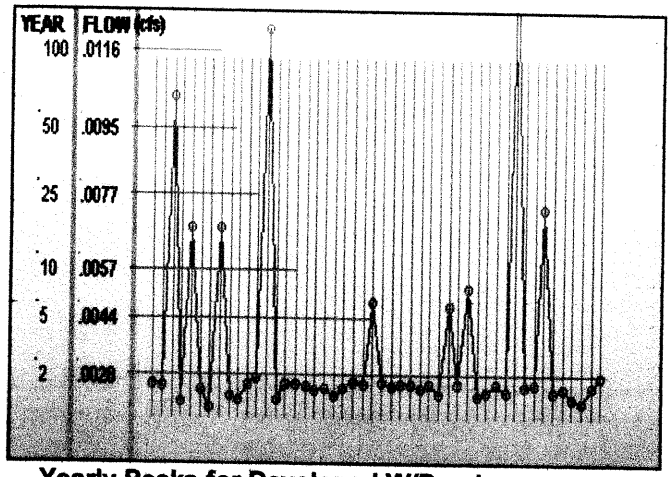
Flow Frequency Chart



Yearly Peaks for developed W/O Pond



Duration Graph



Yearly Peaks for Developed W/Pond

APPENDIX G

Kensington Estates Case Study by AHBL, dated February 6, 2002.

PROJECT MEMO

To:

FROM: Glenn Hume

DATE: February 6, 2002

PROJECT: Low Impact Development

OUR FILE NO.: 201462.30

SUBJECT: WWHM Comparison Analysis

AHBL
CIVIL & STRUCTURAL
ENGINEERS▲ PLANNERS

The purpose of this analysis was to provide general comparisons for the total volume of stormwater storage required for a conventional residential development versus a low impact development (LID) design by utilizing the new Department of Ecology (DOE) standards. Kensington Estates, a residential development in Pierce County on a 23.92-acre site approximately 4 miles south of Puyallup, was used as the case study site. The Western Washington Hydrology Model (WWHM) developed by the DOE was utilized as the design tool in sizing conceptual stormwater facilities. The WWHM is an continuous model based on HSPF developed by DOE to provide a tool to design and analyze a storm facility's ability to meet the new DOE requirements of matching pre-developed and developed peak flows and also matching flow durations from half the 2-year storm to the 50-year design storm. This new quantity control requirement, established in the *Stormwater Management Manual for Western Washington*, August 2001, is similar to the King County requirements for Level 2 quantity control. Following is a list of the assumptions and input used to compare the stormwater storage requirement for conventional development versus Low impact development. The resulting volumes are provided in the attached table for comparison (see Attachment #1).

General Assumptions:

1. The total site area is 23.92 acres.
2. Soils are predominately Type C soils, modeled as till soils in the WWHM.
3. There is an existing wetland located near the south portion of the property line.
4. Existing conditions are predominately forested (pre-developed conditions of forest are required by the WWHM unless there is historical evidence that the property was pasture prior to the influence of man.)

Conventional Development Assumptions:

1. Area input values for conventional development analysis were obtained from the *Pierce County Low Impact Development Study* by CH2MHILL, dated April 11, 2001.
2. All roof drains are tight-lined to closed-pipe conveyance system located in the road network.

2215 North 30th Street, Suite 300, Tacoma, WA 98403 / 253-383-2422 / FAX 383-2572

3. Roads consists of asphalt concrete pavement with curb and gutter and sidewalk. Stormwater conveyance is through a network of catch basins and closed pipe discharging directly to the quantity control facility.

4. The developed site was modeled as a single basin.

5. Existing wetland and wetland buffer area was not included in the basin input for pre-developed or developed basins.

6. The conventional design utilizes a single detention facility. The detention design was evaluated using the WWHM and the new DOE standards.

7. Stormwater quality requirements are met via a wetpond. The required wetpond volume was calculated utilizing the Waterworks program. Waterworks is an event-based program that utilizes the Santa Barbara Urban Hydrograph (SBUH) method with Type a 1A rainfall event to determine total volume of stormwater runoff for design events. The treatment design event used to size the wetpond was the 6-month, 24-hour storm event with a total precipitation of 1.28 inches.

Low Impact Development Assumptions:

1. Basin area values are based on the Low Impact Site Plan developed by AHBL.

2. All roof drainage and road runoff is routed through a network of swales and rain gardens with a total flow length of greater than 50-feet prior to discharge to detention ponds.

3. The rain gardens provided and grassed swales meet the minimum requirement for runoff treatment.

4. Due to flow length through vegetated areas, all roof area is modeled as grass.

5. Open space retained on the site is in forested conditions.

Method of Analysis

6. The site is divided into four basins (see Attachment #2). Each basin has its own stormwater quantity control facility.

    a. Basin B1 is the northern portion of the site. This basin sheet flows towards the west. The western portion of this basin has been left undisturbed to allow for dissipation of stormwater runoff into the natural forest. This basin does not meet the DOE requirement for full dispersion. To obtain the full dispersion credit, eliminating the need for quantity control ponds, the basin must be 65-percent undeveloped and the total impervious area must be less than 10 percent of the basin area. Currently, as shown, Basin B1 is 55-percent undisturbed. This does not meet DOE requirements, therefore; a stormwater detention pond was developed for this basin.

b. Basin B2 is the southwest portion of the site. This basin sheet flows across the southwest corner of the site and is partially intercepted by the ditch adjacent to 152 Street E.

c. Basin B3 is the wetland and buffer area and the portion of the site directly tributary to the wetland through sheet flow. It was assumed that this basin in the developed conditions would be allowed to discharge directly to the wetland because we have reduced the area tributary to the wetland and the developed area tributary to the wetland consists of lots and undisturbed open space. All roof runoff will be sheet flowed or flow in swales for a minimum of 50-feet prior to discharge to the wetland buffer.

d. Basin B4 is the southeast portion of the site. This basin sheet flows across the eastern property line.

7. The four Basins were analyzed for ten scenarios, each using a different combination of low impact development concepts. The model scenarios are described below: (the scenario numbers correspond to row numbers listed on Attachment 1)

a. Scenario #1 – In Scenario #1 it was assumed that all roads would be 24-feet wide with asphalt concrete surfacing. Runoff is collected in a network of vegetated swales and conveyed to a stormwater quantity control facility. Rain gardens are provided for each lot or two lots share a common rain garden. By use of rain gardens and vegetated swales, it was assumed that the house roof area may be modeled as grass and not impervious surface. As stated earlier, undisturbed areas are assumed to be in a forested condition.

b. Scenario #2 – Scenario #2 is set up the same as #1 except the roads are 20-feet wide.

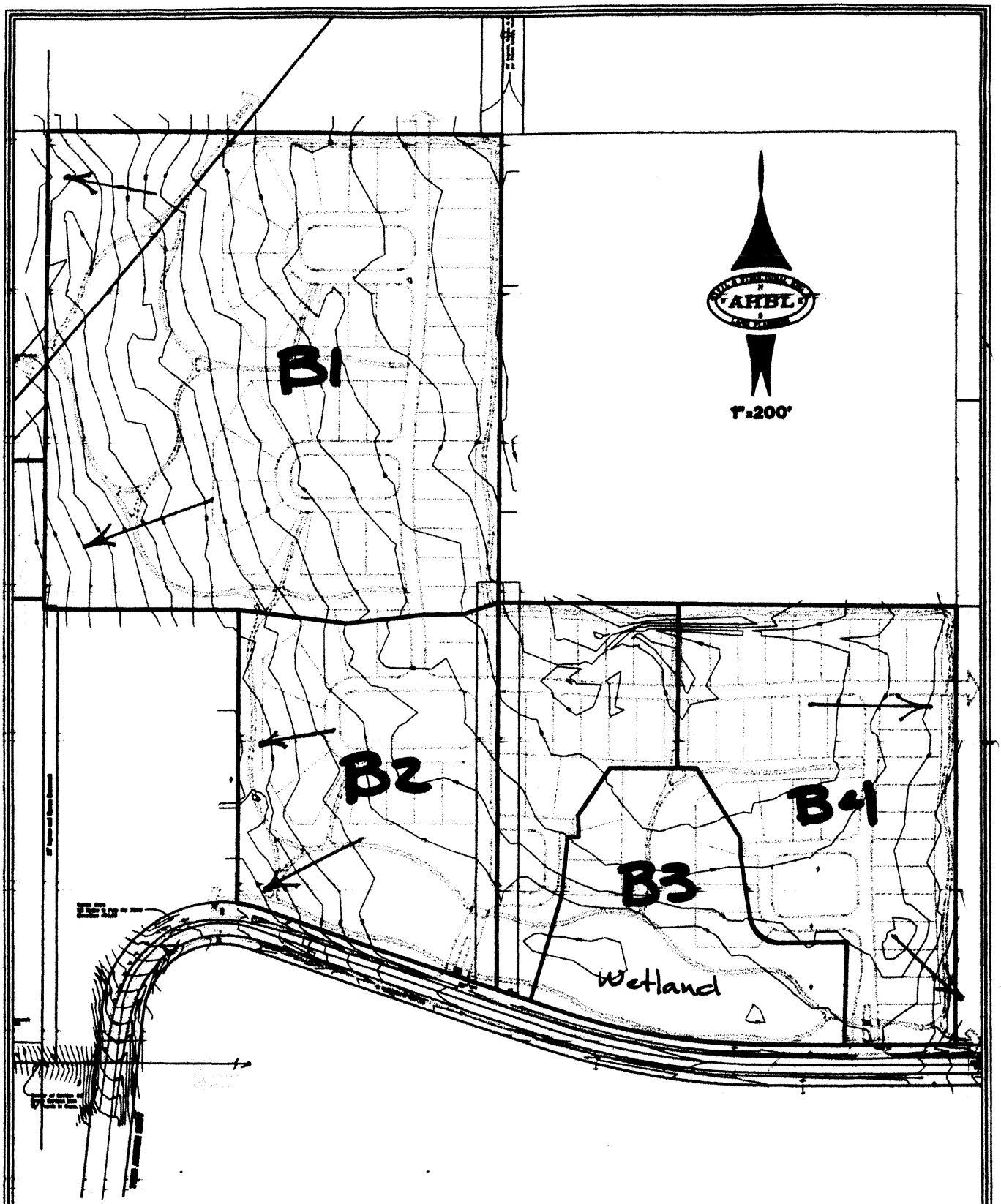
c. Scenario #3 – Scenario #3 is set up the same as #1 except the 24-foot roads are constructed of a pervious pavement system. The credit for pervious pavement is equal to the maximum credit allowed by the WWHM.

d. Scenario #4 – Scenario #4 is the same as #1 with the addition of Pin Foundation systems. Based on the analysis by Rick Gagliano of Pin Foundations Inc., it was assumed that on average 47.7 percent of the undisturbed soil profile under a house would be 'activated' by the use of pin foundations. Pin foundation systems are constructed so that the majority of the natural soil profile is maintained under the house. Runoff from the house's roof is directed onto the lot and is allowed to flow through the soil profile under the house. The term 'activated' refers to the portion of the soil profile that is left undisturbed to which runoff from downspouts can be directed. The percent of activated soil under the house if a function of site topography, house configuration, and downspout location. It was assumed that the 'activated' soil profile could be modeled as pasture. Therefore, in the scenarios where pin foundations are utilized, it is assumed that 47.4-percent of the roof area may be modeled as pasture. In Scenario #4 the remaining

Row #	Basin	B1	B2	B3	B4	Total Volume (ft^3)
1	24-foot Road	32,600	27,743	-	20,577	**80,920**
2	20-foot Road	29,881	25,434	-	18,864	**74,179**
3	24-foot Pervious Pavement	29,636	25,221	-	18,706	**73,563**
4	24-foot Road/Pin Foundation	29,606	25,195	-	18,687	**73,488**
5	24-foot Perv./Pin Foundation	26,621	22,655	-	16,803	**66,079**
6	24' Road/Pin 52.3% Impervious	39,991	34,033	-	25,242	**99,266**
7	24-foot Road/Imperv. Roofs	48,730	41,478	-	30,764	**120,972**
8	24-foot Perv. Pvmt. As Grass	20,766	17,672	-	13,107	**51,545**
9	20' Perv/ Pin Foundation	24,446	20,804	-	15,430	**60,681**
10	20' Perv as Grass/ Pin Found.	17,496	14,889	-	11,043	**43,428**
	Conventional Development	Detention Storage		Wetpond Storage		
		222,590		47,480		**270,070**

* assumes 47.7-percent of roof area can be modeled as pasture
- values in shaded boxes have been computed based on percentages established by Basin B2 and not on actual model iterations.
- area input values for the conventional development analysis are from the *Pierce County Low Impact Development Study* by CH2MHILL, dated April 11, 2001.
- Wetpond assumed for treatment in conventional development. Design volume based on single event model.
Revised 12/20/01

Attachment #1



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BASIN AREAS
LOW IMPACT DEVELOPMENT

ATT. 2